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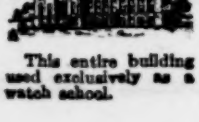

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NOVEMBER, 1918

SOCIAL CONDITIONS IN THE PIURA–TUMBES REGION OF NORTHERN PERU

By PHILIP AINSWORTH MEANS

BOSTON, MASS.

IN many parts of the world there are countries which once were the exclusive property of a semi-civilized or civilized race with a very definite cultural character of its own. Now, because of the expansiveness of modern commerce, practically every one of these countries has been invaded, either through definite and political colonization or through indefinite and non-political commercial influences, by the white race of Europe bearing with it one phase or another of its own distinctive civilization. Consequently there has grown up, during the period between about 1450 and the present, a long series of countries having a dual population and a dual culture. In some cases this quality of duality has given rise to hybridity and harmony (as in French Indo-China), but more often it has given rise to social and racial disparity and disharmony (as in Latin America). The question of whether racial contacts of this kind were harmonious or not seems clearly to have depended on both the intellectuality of the invaded race and culture and on the magnanimity and astuteness of the invading race and culture.

I purpose to examine here the present conditions in a restricted area where the race and culture contact has always been of an unfortunate character, albeit by no means so much so as elsewhere in Peru and Latin America as a whole.[1]

In the first place, it will be well to sketch rapidly the chief geographical and historical facts about the Piura-Tumbes region. It forms the northernmost section of the long coastal desert which fringes the west coast of South America from Tarapacá in Chile up to the Gulf of Guayaquil between Peru

[1] See the present author's former articles on this subject: *Science*, September 13, 1918; *Journal of Race Development*, October, 1918.

A STREET IN THE POORER PORTION OF CATACAOS, PIURA VALLEY. The houses are badly built, the materials being wood and sticks daubed over with a coating of mud.

and Ecuador. As elsewhere in this desert littoral, there are, in the Piura-Tumbes region, transverse rivers which flow through very fertile valleys from the mountains of the interior to the Pacific Ocean. In the Piura-Tumbes region these streams are three in number, their names, from North to South, being: the Tumbes River (perennial), the Chira River, (perennial) and the Piura River (seasonal). Each of the valleys is exceedingly productive and rather thickly populated for Peru. (I should incline to say that the density averaged between 20 and 40 to the square mile.)

From the earliest pre-Columbian times this region has been productive of fine cotton, fruits and vegetables. Politically, it was part of the great Chimu confederation until, about 1450, that confederation was absorbed by the Incas. The people belonged to the Yunca or Mochica stock general on the coast. In 1532 Pizarro entered the region and set up Spanish power there. Since 1550 the population has been divided, on ethnic lines, into three groups: Pure or nearly pure Indians; pure or nearly pure whites; and *mestizos* or mixed-bloods of white and Indian parentage or ancestry. (There are, besides, a few Negroes and Orientals and their descendants, but they are unim-

A FISHING BALSA AT CHULLILLACHE, NEAR THE MOUTH OF THE PIURA RIVER.

portant from the point of view of this paper.) As nearly as I can judge from my own observations and from some figures given me by two anthropologically inclined parish priests in different parts of the region, the pure or nearly pure Indians form about 50 per cent. of the poulation, the *mestizos* form 35 per cent., the pure or nearly pure whites 10 per cent. and the other races 5 per cent.

The pure or nearly pure Indians fall, on occupational grounds, into two categories. The larger is that which devotes itself to agriculture, and the smaller is that which follows the sea, gaining a livelihood from fishing or as sailors. The agricultural category dwells for the most part on the huge landed estates into which the valleys and the intervening deserts are

THE CHIEF PLAZA, CATACAOS, PIURA VALLEY. The tower to the right is all that is left of the parish church, destroyed by an earthquake some years ago.

largely divided. They act as laborers for the owners of the estates, receiving a wage of about a *sol* or a *sol* and a half a day (fifty cents equals one *sol*). The working day is about ten hours, the working time being arranged so as to permit of a siesta during the mid-day heat. Each family has its own house and lot. There seems to be no lack of food, and the relations between the laborers and the employers seem to be genial.

The state of the Indians, however, is by no means idyllic. Their houses are too often merely wretched huts made of old corn-stalks, canes or gasoline-cans. The people have in general no sense of how to keep either their persons or their houses clean. Vermin and animals roam freely all over the hut, often dropping in close proximity to the food. The cooking utensils

A STREET IN THE VILLAGE OF CHULUCANAS, PIURA VALLEY.
These houses are unusual, having tiled roofs.

are usually gourds or old tin cans and are usually in a condition of remarkable filthiness. There is absolutely no privacy in these houses and a large family often sleeps indiscriminately huddled together. It is not to be wondered at that diseases and bad habits are quickly communicated under these conditions. Clothes are often merely dirty rags.

On some *haciendas*, and in some Indian households, the situation is far better. The houses in some of the villages on the *haciendas* of Sojo and Macacará,[2] in the Chira Valley, are a

SOME OF THE PEOPLE OF CHULLILLACHE, NEAR THE MOUTH OF THE PIURA RIVER.

[2] The property of Don Miguel Checa and Don Alfredo Checa-Eguiguren.

great deal cleaner and more spacious than those of which I have spoken above. They are also better built, and the people have good clothes, which they change quite often, keeping themselves reasonably clean into the bargain. On a number of other *haciendas* similar conditions prevail, the *haciendas* in the Chira Valley being, on the whole, better conditioned than those in the two other valleys. This is probably due to its greater accessibility and to the fact that absentee landlordism is here at a minimum.

The maritime Indians live, for the most part, on land which has no formal possessor. They work for themselves or for the headman of their community, not for a white employer. Their houses are of the most primitive description; driftwood, old bits

A Cotton Field on the Hacienda San Ysidro, near Sechura, Piura Valley. This hacienda, belonging to the Perez-Vasquez family, is managed by Don Victor Chavez, and is one of the best of the smaller haciendas in the Piura Valley.

of tin cans, bundles of dried grass and similar material being used in combination. Chullillache, a small port, or rather roadstead, near Sechura in the Piura Valley, is a typical community of this description. Colan, between Payta and the mouth of the Chira River, is another. About 400 souls live at Chullillache. In the early morning, before sunrise, all the men and boys go out to sea on their *balsas*, raft-like craft provided with a mast and sail. They take their nets (beautifully made) and with them encircle a good area of water. The circle is gradually reduced until the catch, almost always plentiful, is made. The *balsas* return home about noon. The women then aid in the cleaning and drying of the fish, which is later sent up the valley to Sechura, Catacaos, Piura and other towns, on donkey-back.

A LARGE IRRIGATION DITCH ON THE HACIENDA OF SOJO, CHIRA VALLEY. This hacienda, belonging to Don Miguel Checa and Don Alfredo Checa y Eguiguren, is one of the largest and finest in Peru. The large white house in the background (two miles away) is the mansion of the hacienda.

The population of the larger towns consists, with the exception of a small proportion of pure Indians who go out to work their fields every day, of *mestizos* and a few whites. The houses of this class are mostly built of *adobe*, often whitewashed, and from the front they look fairly substantial and sophisticated. Inside, however, a great degree of filth and slovenliness is often encountered. The clothes of the *mestizos* are much better made and more numerous than those of the Indians (except the richer class of Indians already alluded to). Proximity to market and to shops where canned food can be bought tends to make their diet better than that of the country folk. Though most of the *mestizo* class is occupied in shop-keeping, hotel-keeping and kindred employments, not a few of them are landowners, lawyers and clerics. The richer and more educated ones, of course, often have really good houses, well furnished and often provided with a good piano or with a victrola.

The temperament of the Indians is, in most localities, one of joviality and good humor. When skilfully superintended they work industriously enough, but when left to themselves they become spasmodic in their activities. On the whole their health and vitality are good, though *viruela* and smallpox are not unknown. Vaccination is now compulsory and is fairly well enforced. I saw very little venereal disease in the Piura-Tumbes region. The clean dry air of the desert tends to keep all illnesses at a minimum, although the conditions of living are often bad. Most of the children now get at least some instruc-

tion in reading and writing, but illiteracy is common among the older folk. At Tumbes and Morropón I found the health conditions to be much worse than they are elsewhere. Bad irrigation, unaccompanied by proper drainage, has brought about a number of bodies of stagnant and pestiferous water. Malaria and various forms of anemia are common in both those places.

Among the *mestizos* illiteracy is unusual, but many of them, and especially the women, have a peculiar bovine stupidity caused by a total lack of any sort of stimulating mental exercise. Unlike the Indians, the *mestizos* are given to unduly heavy drinking. One sees surprisingly little drunkenness in the Piura-Tumbes region, and most of what is seen is confined to the *mestizo* middle class.

The whites chiefly fall into two groups: the land-holding gentry, and the professional men and their families. Socially, of course, it is difficult to distinguish between them. They are all well educated and delightful, being among the most genuinely hospitable people in the world.

It is a difficult matter to exaggerate the power for good and likewise for evil which rests in the hands of the land-holding portion of the white upper class. On their vast estates the *hacendados* rule with unquestioned authority, using a system of overseers and headmen which has its roots in the ancient Inca régime. I am prepared to say that the great majority of the *hacendados* in the Piura-Tumbes region do not abuse their power, but neither do they avail themselves of the almost limit-

THE MAIN HOUSE ON THE HACIENDA OF SOL-SOL, PIURA VALLEY. This hacienda belongs to Senator Victor Eguiguren, and it is typical of the more old-fashioned type of hacienda-house.

HOUSES AT CHULLILLACIE, NEAR THE MOUTH OF THE PIURA RIVER. The logs on the right were brought all the way from Guayaquil for the purpose of building balsas.

less opportunities for bettering the condition and brightening the lives of the Indians and *mestizos* on their estates.

What Peru (and by implication other Latin American countries) needs just now is benevolent paternalism systematically striving to build up a wholesome, sane and virile peasantry, similar to that of France or to that of Switzerland and that of parts of Italy. I am well aware that paternalism of any sort is generally looked upon in this country as anti-democratic. But is it really anti-democratic? Those who declare it to be so lose sight of the very important fact that in a large proportion of the

SOME HOUSES OF THE SOMEWHAT IMPROVED TYPE, AT TUMBES.

world the mass of the people is not yet ready for democracy, even for the simulacrum of democracy which prevails in this country and in England. Yet in such lands, and especially in countries like Peru, a certain small minority—the enlightened upper, or dominant, class—is already fit to receive and to employ rightly real democracy, the democracy which recognizes the ineradicable inequalities existent in mankind and provides suitable social machinery to enable a gifted individual to reach the highest place in society to which his qualities entitle him. The problem which faces such countries is that of making the mass of their people as fit to receive true democracy as the minority now is. Only one social force, benevolent and progressive paternalism, is capable of carrying out this task. Ob-

A View Westward over the Chira Valley from the Verandah of Sojo.

viously some forms of paternalism, the stultifying and oppressive paternalism of early Etruria, of ancient Egypt and so on, are indeed anti-democratic. But the sort of paternalism which is already making its appearance in Peru and elsewhere in Latin America, a paternalism which seeks diligently to fortify the bodies and strengthen the minds and invigorate the souls of the masses, is far, far remote from any tinge of anti-democracy. On the coast of Peru to-day, I am convinced that selfish exploitation of the Indian and other laborers by the upper class (the *hacendados*) is the exception, not the rule. On the other hand, I also believe that *hacendados* like Don Victor Larco y Herrera (of Trujillo) and Don Antonio Graña y Reyes (of Huacho) and a few others, all of them systematically seeking to make every sort of condition on their estates as good as

UNIMPROVED HOUSES AT TUMBES. Built on piles because of floods.

it can be made, are likewise the exception and not the rule. In short, I believe that the *will* to be benevolent is by no means wanting, though the information as to *how* to be benevolent and the realization of the importance of being actively benevolent undoubtedly are wanting.

For the purpose of illustrating my point, I will say something of what this sort of paternalism might accomplish in the Piura-Tumbes region.

A *hacendado* who decides to devote himself whole-heartedly to the task of building up the physique and mentality of the dwellers on his *haciendas* should study intensively the temperament and the abilities of those whom he seeks to benefit. It will be found that the inhabitants of one village on an estate will have a peculiar aptitude for weaving, those in another, perhaps only half a mile away, will be especially adept at making objects out of wood, leather, straw or other materials. Again, the men of one village will be much better and more conscientious tillers of the soil than those of another, although the latter may have a special ability in making adobe or in carpentry. All these variations must be studied, and the special abilities must be taken advantage of, though wisely, not arbitrarily.

When he thoroughly understands his people, and knows all their little tricks of mind and all their prejudices, the *hacendado* will know how best to set about his task, and how to avoid outraging old usages or established habits of mind. He should especially refrain from drawing undue attention to his activities, for if he does, some one will be sure to start acting against him and undoing all his work. He should be patient, and should

make up his mind that, for a long time, he will have to go very slowly. Gradually and unobtrusively he should persuade the people to tear down their present unsuitable and insanitary dwellings and he should see to it that the materials for erecting new ones of good adobe, or, better yet, of concrete, are readily accessible. When several new houses are thus built, he should announce that in view of the fact that a spirit of progressiveness seems to be abroad he will do what he can to aid those who are not sufficiently well-to-do to provide for themselves good houses of the new type. This would spur on the laggards, and, after a time, the whole village will be composed of neat, sanitary and pretty houses of adobe or concrete. The next step should be that of developing the love of beauty which is latent in the people. Flower-beds and shrubs should be planted along the streets, and in the plazas (in many places this is already done). To counteract the glare of the bright sunshine, the people should be shown the beneficial results of eschewing whitewash, and of painting their houses dark gray, or brown or other subdued colors. The ceramic ability of the people should be directed toward tile-making, so that good material for roofs (now usually made of poor thatch) may be easily available. Finally, but perhaps most important of all, there should be provided suitable sanitary arrangements, baths and so on. Many travelers in Peru have declared that the peasantry is averse to bathing. This is not so. Whenever a village is near a river the people wash themselves with great care. It is only lack of facilities for washing that makes many of them go without it. In the

A Scene in the Desert near Tambo Grande, Piura Valley.

The large tree is a zapote.

A VIEW IN THE PIURA VALLEY NEAR CATACAOS.

mountains the excessive cold and the lack of means for heating appreciable quantities of water are the chief causes of the general unwashedness of the mountaineers. All this can be remedied, and it should be—by the *hacendados*.

These reforms having been instituted, the scarcely less important ones of introducing better utensils for household work and of encouraging the use of better clothes should be effected. In connection with clothing, the people should be urged not to give up their wonderful hand-woven woolen and cotton textiles in favor of the poor quality and rather dear foreign-manufactured calicos and ginghams which are being extensively in-

THE PLAZA AT SECHURA, NEAR THE MOUTH OF THE PIURA RIVER.

troduced. Personally, I am convinced that the Piura-Tumbes region could be made not only one of the greatest textile fiber-producing regions in the world, but also one of the greatest textile manufacturing regions. Excellent cotton and wool are already produced there. With proper scientific study and preparation, the two other great textile fibers, silk and flax, could also be grown in large quantities. I would strongly urge that the ordinary factory and mechanical methods of manufacture be not introduced, at least not in totality. The people of the Peruvian coast have, for many centuries, manifested a genius for hand weaving. It is a pity that this genius should be stultified by the ordinary super-efficient but entirely unimaginative manufacturing methods of other countries. Instead, I think

THE CHURCH AT SECHURA. Built about 1750, to replace the older one which was destroyed by the earthquake of 1746.

that the people of the Piura-Tumbes region and other parts of the coast should be provided with hand-looms sufficiently improved to ensure commercial profit, but yet of a sort which will allow play to the imaginative and technical abilities of the Indian weavers. Such a combination of qualities would not be unduly difficult to arrive at. In my opinion these people, given cotton, wool, silk and flax linen to work with, and given just the right type of loom, would very quickly show the world new sorts of cloth, and new combinations of material and pattern which would profoundly stimulate the jaded esthetic faculties of the world's dressmakers, tailors and upholsterers. Quality, not quantity, should be the aim. The fact that Piura linen, Piura cotton, Piura silk, or Piura linen-and-silk, or Piura linen-and-cotton or other Piura fabrics were excessively fine and beau-

A VIEW OVER THE TOWN OF MORROPÓN, PIURA VALLEY. Note the two bodies of insect-breeding stagnant water. There is much malaria at Morropón.

tiful, even though proportionately dear, would not in the least impair the demand for them, any more than it does the demand for any other choice article of luxury.

I mention the matter of weaving simply as an example of the sort of commercial activity, based upon the most fundamental traits and abilities of the people, which might be created by the exercise, on the part of the *hacendados*, of the correct sort of paternalism. Commercialism of this description, far from being baleful, would give depth and meaning to the bet-

THE VILLAGE OF YAPATERA, ON THE HACIENDA OF SOL-SOL, PIURA VALLEY. This is a typical unimproved Indian village. There is no provision here for any sort of diversion for the people, nor is there even a church and a priest, the nearest being at Chulucanas, some miles away.

tered conditions of life. It would be very powerful in creating a sane and self-respecting peasantry, half commercial and half agrarian, from whom the material for real democracy would ultimately be derived.

To aid in the work, attention must be given to such matters as sports, both individual sports like boxing, wrestling, fencing and foot-racing, and team-sports, preferably football, lacrosse and basketball. The beneficial influence of these games in creating a spirit of generosity, self-reliance and general virility is well recognized in this country and in England; it is beginning to be realized in the Latin countries, and sports of all kinds are already common among the upper class in Peru. But the task of making the *hacendado* perceive the necessity of providing sports for the Indians is as yet only just begun. Of diversions of a more mental and intellectual type the cinema can be made one of the most beneficial. Films that show life as it really is, especially those in which humor (real humor) is important, and films of all kinds provided that they are free from indecencies and brutalities, should be shown in every village of appreciable size at least two or three times a month.

I have reserved mention of the importance in all this of the priest and the school teacher till the last, for the reason that it is obvious. These two individuals can do things that the *hacendado* can not. It is for them to give point and authority to his efforts, and to supervise the actual carrying out of his carefully planned reforms.

To many, especially to the hawk-eyed and sour-visaged type of predatory European or North American commercial traveler (one is often tempted to term him a peripatetic despoiler of the unsophisticated), all that I have said will seem distinctly utopian. But that opinion will be caused by the fact that they look upon the Indian and *mestizo* with a view to discovering what they can *get out* of him rather than what they can *put into* him. I have studied this matter very closely in a number of representative regions in Peru and Bolivia, and I know that, even where the present conditions are seemingly most hopeless, there is *some* hope. In regions like that which I have called the Piura-Tumbes region, where even to-day conditions might be much worse than they are, and yet be better than those prevalent in the remote mountain districts, the human material which offers itself to the manipulations of benevolent and constructive paternalism is full of latent possibilities of a most cheering sort. Whether or not these possibilities become actualities depends on the *hacendados*, and on the upper class as a whole.

THE RATIONALE OF TESTING INTELLIGENCE, WITH SPECIAL REFERENCE TO TESTING IN THE ARMY

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A BRIGHT young man went to the Harvard Graduate School to investigate the freedom of the will. After two or three years of investigating, he concluded that there is no such thing!

For some decades, we psychologists have been measuring general intelligence. Are we sure there is any such thing? Investigation has been steadily deleting the definite article out of psychology: "the" memory, "the" imagination, "the" intellect —to use these terms with serious face is a confession that you have been reading the antique books on "mental philosophy" and neglecting the modern ones on differential psychology.

But is not *general* intelligence "the" intelligence? Can it fare any better? And to test it—is not that like testing the pulling strength, not of horses, but of "the" horse, a logical concept which stands in nobody's stable?

There are certainly two sides to the question, unless we can make out definitely the meaning of the phrase. It appears that general intelligence can be defined in terms of (1) mind, or of (2) brain, or of (3) environment.

1. The word "intelligence" throws back by contrast that which we are *not* measuring, namely, the feelings, and (if there is any such thing apart from intelligence and feeling) the will. Sensation and the sense-complexes, perception, memory, imagination and thought, these constitute intelligence. General intelligence is efficiency in the formation of sense-complexes as a means of dealing with the outside—yes, and the inside, world.

2. Speaking in terms of the brain, we know that it has two general levels: the lower level, like the entire brain of such an animal as a dog or a cat, is composed of centers which respond, more or less independently of each other, to such outer subjects as can excite them. The visual tracts see, the auditory neurons hear, and so on. The intelligence of a dog, or a horse, or of a one-story-brained *homo*, is the net result produced by these centers, unguided as they are, by any superior neurons. And such, too, roughly, is the intelligence of even a bright child, whose higher, reflective nerve cells have not yet come to command.

But these nether neurons of the brain are like the privates

of an army, taking the direct shock and beat of the aggressive world about. The superior cells are the headquarters of another kind of general intelligence, a kind of commanding general intelligence. It has a dual duty: it deals with concepts, symbols and abstractions instead of material things; and it issues general orders to all subordinate centers.

Here is the home of "the" faculties, "the" attention, for example, which gives the command, "Attention," to all the lesser faculties, visual, tactual, auditory, and the rest, and reminds them to "make it snappy"! Here, too, lies the reason why it is so much easier to test the intelligence of a high, than of a low, subject: it is the difference between getting a single report from the head of a unified command, and collecting the muster rolls of all the scattered detachments of a Russian or a Mexican army. Also, here is one explanation of why testers are so prone to use numbers, words, symbols, concepts, abstractions, in their measuring schemes: they commit the psychological fallacy of assuming that others are like themselves, double-decker intelligences, and that in so far as one can deal with these higher things, certainly all the lower must have been added unto him.

"General" intelligence, from this point of view, is the unified, supervisory intelligence of the superior centers of the brain.

Finally, intelligence is (intellectual) power of adaptation to environment. This involves (*a*) sensing the situation, perceiving it, (*b*) comprehending, elaborating, perhaps analyzing or synthesizing it, and (*c*) responding (mentally) to it. "What would you do if you missed your train?" To ask this question of a subject is next best to seeing him in such a situation. He must exercise his "sense of reality" on it, size it up, plan his reaction. Testing seems simple enough.

But this world is made of situations. And if they are new enough to require much adaptation, we may not be able, with words merely, to create in the test room a replica of them that will be *real*. It is useless to ask a savage what he would do if he missed his train, or an old bachelor what he would do when the baby cried, or a green soldier how he will behave when a shell bursts near him. Further, just which of many millions of situations are so important, or so typical, or so closely correlated with a web of others, similar or dissimilar, that they should be admitted among the select few that form a test? The answer is coming as a slow deposit from the stream of experience and experiment.

If we are clear as to the more obvious outlines of what we

are testing, the next question is, what are we testing *for?* It would be interesting, and perhaps instructive, to collect from common life many varied instances of the application of test processes.

Teasing, teasing,
Just to see what you would do;
Teasing, teasing,
To find out if your love was true.

Here is a thrilling test, with a fairly well-defined object. So Abraham undergoes a kind of divine teasing, to find out if his love for God is true enough to compel the sacrifice of his son; Elijah sets up a test to find which Lord really is God enough to make the fire fall; the farmer tests his seed by planting a sample; a small metal column is cast beside a great pillar, and of the same stuff, to find its breaking strength, and so on.

What is all this for? Not for classification merely, but for *action.* It is not a mere museum arrangement of individuals that we are working for, to put them in place and gaze at them: we want to know what some person or persons can or will do in our common environment, or in some special situation. That is the best test, and he is the best tester, that can most definitely predict and control how the subject will turn out. This is the test of a test, designed to lower any prematurely lifted brow that may be found among us.

Let us suppose a complex machine, consisting of many parts, such as an automobile, or the brain of a soldier, which must perform under new and trying conditions: the soldier is going to France; the automobile is to leave the paved and level streets of the city for country mud, hills, ruts and rocks. How, here in the garage, can we find whether our machine will stand the new strain? That test will tell best which is most like the new conditions that must be met. A certain automobile company, wishing to test out tires, exhausted all its laboratory ingenuity in vain, and finally fell back on an actual run of the road, through thousands of miles, as the only test conclusive.

But war will not wait for soldiers to be selected on this plan. They must be tried out in the tent, so to speak, and quickly, by our best means of predicting what they will do in the fighting field.

Let us have a symbol or two: Let T stand for the great and ultimate trial and test, which is life itself; *t* shall be our petty laboratory test, by means of which we predict how the subject will turn out in T, the life situation. Then we can safely lay down the general principle that *t should be as much like T as possible.* It is the old laboratory game right over: construct a

miniature of your big problem, keeping the same principles at work. So the electric spark in the physical laboratory is a small sample of lightning, and the first wireless waves we know of traveled half way across a room instead of half way around the world.

There are at least two special reasons why *t* should be like T in much human testing. The first is that only so can we be sure of inducing the *attitude* necessary for success in T, and that is half the battle. "The will to win is half the victory." The animal psychologist meets this demand by setting his task, perhaps the threading of a maze, between the animal and some strong natural satisfaction, as that of hunger. Trivial as it may sound, there are few American soldiers who would not work hard at an intelligence test that permitted them, in some symbolic way, to can the Kaiser! On the other hand, if there is something about *t* that rouses the subject to supreme effort, whereas T proves so dull as to leave him apathetic, he will be rated too high. Perhaps the constant attitude of "You're in the army now," which means among other things, that you will put through what you are told to do whether you like it or not, makes this warning less necessary in military testing. But we know how much *morale* counts in execution—and *morale* is simply mental attitude.

The second reason why *t* should resemble T is that *t* may be so specialized and limited as to miss some of the important action features of T altogether. In case of the automobile, for instance, we might test its valves, radiator, carburetor, transmission, and so on—do not advertisers thrust some one of these things into our attention as if it were the whole car?—only to find that a bad spring or differential or axle made proper performance impossible. It is the total run that counts.

To put it in terms of neurons, or, as Thorndike would say, connections: T is bound to bring into play certain nervous connections between stimuli and responses. In any such complex situation as soldiering, there is sure to be a wonderful web of them, some old and well worn, some thoroughly new. Through *t* we must find out whether our subject actually or potentially has these connections. Testing them all, in a limited time, is often out of the question. We can (1) test a certain few of these connections which seem to be typical and fundamental, or (2) test other connections whose functioning is highly correlated with that of the T-neurons, or (3) test those connections, relatively rather low-lying in the brain perhaps, which are involved in the exercise of "common-sense," assuming that one who has a good sub-structure of common-sense connections

can probably build up a superstructure of special-purpose connections, or (4) test the high-level neurons with symbols, thought processes, etc., taking it for granted that any brain which is equal to these lofty tasks can certainly perform all lesser. Actually, in the army, we are doing all four.

If we are testing old achievement, which will not require much variation to fit it to new conditions, *t* can almost become T, as in the trade tests in the Personnel Department of the army, where a man actually drives a truck as a test of his truck-driving intelligence. But as a rule, some adaptation to the new is required in T; and if we merely bring well-established connections into play in *t*, such adaptation is but doubtfully tested. But if *t* is *absolutely new*, as when we ask a savage what he would do if he missed his train, or if we use strange language, or require really new reasoning processes, it is too difficult. The solution lies in a *new combination* of *old mental materials*. So it is not surprising to find that we can distinguish the feeble-minded from the normal much less well by having them count forward, or tell their age, or go through some other practised activity, than by having them count backward, or answer problem-questions. The adaptable mind distinguishes itself, not so much by the wealth of its information, but by its ability to organize its facts and processes in new ways to meet new demands, to set its neurons to work in new systems, involving new connections.

Now, *t* is like a small stereopticon slide by means of which we project our picture of what the subject's larger future performance will be. For this reason, we must take care that *t* is not marred or distorted by anything which is not likely to enter into T. For example, objection is sometimes made to certain tests used in the army, on the ground that they require reaction within a fixed time limit, and a limit so brief that no subject ever completes the full test. But the military game is a fast one: wherever the soldier is placed, he is likely to find fast intelligence at a premium as compared with slow. To some extent, this principle would even justify the examining of recruits who are undergoing the effects of fatigue or inoculation, since the military T demands a clear head in spite of a suffering body. But in *t*, it is difficult to make the suffering uniform, and so make it fair.

It may help us further in determining what our scheme of intelligence testing should be if we consider what a complete inventory of intelligence would require. There are here, as everywhere, two great questions to be answered, What kind? and How much? To find a way to the answering of these ques-

tions, we must revert to the nature of intelligence and analyze it a bit further.

"Intelligence is intelligence," it is sometimes said, "whether in the skull of a Negro, white man or Chinaman. There are no *kinds*." I believe the bio-psychological concept of *traits* will help us here. To put it briefly: the cerebrum is not a single, simple, homogeneous organ, but rather a collection of organs. Doubtless there are separate determiners in the germ plasm for its separate parts, so that these parts are "independently heritable and independently variable." These parts—call them centers, or better, tracts—are the cerebral counterparts of those various objects or aspects of the environment which it has proven most important, evolutionally, for man to respond to. Each of these tracts is the seat of a trait. And each trait should be defined, not in purely mental terms, but as a reaction to something environmental, as the trait of acute color perception, or the ability to remember words well. A person is the sum of his traits.

Here, then, is the basis of the question, What kind? To test one set of traits with *t*, and then use another T, may prove as useless as to test one man and then use another. Tracts may be wanting in this brain or that, and hence the corresponding abilities wanting in the personality.

Now for the question of How much? Intelligence is not a unit power plant, a single motor which can be belted to anything indifferently, with equal prospect of running it. The *ensemble* of mental traits which make up a personality is more like a collection of separate motors of varying size, which, though they may influence each other's running, nevertheless operate ordinarily with considerable independence. In measuring completely the efficiency of a machine, say an automobile, we must find (1) what kind of parts it has and (2) how strong each part is. To measure a mind completely, we must find (1) what kind of traits it has, and (2) to what level of effectiveness each trait rises.

Now, what possible levels are there? Suppose several people have the trait of reacting strongly to color. One may perceive and act, as certain of the lower animals are said to react to red; the second will perceive-remember-act, will admire the rainbow and try to reproduce it when he gets home; the third will perceive-remember-imagine-act, will juxtapose remembered colors in fanciful combination; the fourth will perceive-remember-imagine-think-act, will work out the laws of color contrast, harmony and balance, and so set forth results by rule. The levels of a trait, then, are those of perception,

memory, imagination, and thought. The last two are likely to involve pretty prominently the processes of discrimination, comparison, analysis, synthesis.

Here appears the reason for avoiding the alternative test, the yes-or-no test: it leaves no leeway for trait-power to rise by degrees until it reaches its true test-level, but simply shows presence or absence of some more or less indefinite degree of the trait,—and this not very certainly, since there is always a fifty per cent. chance of a correct guess.

Here, too, we can see clearly the value of special tests for special purposes. We are sometimes asked whether the intelligence test, as used in the army, does not discover special ability of this kind or that, special fitness for some special military position. In a limited way it may do so, and in half-accidental cases; but we can not substantiate any broad claim of this kind. For it is characteristic of the general intelligence test, so far as its *what kind,* its range of traits tested, is concerned, to deal almost wholly with the materials of the everyday environment only—how else could it be fair to all?—and with regard to its *how much,* the height, or degree of the traits, to rise to the level of the thought processes, but to require the most common of them only, and not to run through their whole catalogue. Our test for literates (Alpha) accomplishes these two things by means of *abstract symbols;* and leaves much, in the case of these favored subjects, to *individual initiative;* whereas the test for illiterates (Beta) makes the paper work more concrete, putting in pictures and diagrams, and leads the subject on by the attraction of *imitation,* to do about what he has just seen done on a blackboard.

The general intelligence test, then, tries out simply the central core of consciousness, so to speak, and that in a general way only. Its t is very small as compared with the T, the life situation, for which it tests. Since the ratio t: T is so small, we must be careful how we translate minute and perhaps accidental variations of t into the large and serious terms of T. A few points up or down on the testing scale, in any individual case, may not mean much with regard to pragmatic intelligence, exercised over a long span of time.

Because the general intelligence test leaves unexplored so many traits, and certain ranges of all traits, there are necessary as many special tests as there are special situations into which ability is to be fitted. And they have the advantage that T is smaller, just because it *is* a special, and not a general situation, and hence t can be made proportionately larger. In many cases, t practically becomes T—the ideal situation.

Take a case of this. An Indian captain has told me of an Indian soldier who is blessed with a wonderful "bump of locality." His friends tested this out by taking him to Washington, D. C., pointing out Potomac Park, and then whirling him from point to point of the city in the endeavor to confuse him as to direction. But in no case did he fail, after scanning the horizon a bit, to point straight toward Potomac Park whenever and wherever challenged to do so. It seems certain, after such a try-out as this, that he has at least one invaluable qualification for scouting. In the army, such discovery of a special talent for a particular purpose falls in the Personnel Department.

Let us look next at some of the obvious dangers of intelligence testing. In the first place, we must beware how we use a high-level test to measure low-level intelligence. If our scales are set to weigh nothing less than a hundred pounds or upward, we can not tell accurately the weight of an eighty-pound man. In particular, since devisers of tests are usually expert in the use of literary symbols, and since ordinary test conditions limit seriously the possible variety of responses open to the subject, we slide easily into the belief that a dextrous manipulation of symbols is the prime display of intelligence. No doubt it is true that in an ideally developed brain, the language centers (tracts) are well webbed up with every other trait-tract. Ideally, to experience anything is to be able to utter it. But the stammering lover is matched by the stammering thinker, and there certainly may be intelligent action without the power to put it adequately into words. Probably Cæsar is the only great general who could describe a battle as finely as he could plan it or fight it. Words without deeds, deeds without words: we must be prepared for both. Our old test question, "Why should we judge a person by what he does rather than by what he says," applies to the test itself.

The bulk, and sometimes one hundred per cent., of those who fail in our army test for literates (Alpha) raise their grades when they take the test for illiterates (Beta). This suggests (though it does not prove) that the intelligence is "there," all right, but whereas it can not "come through" in literary terms, it does break out successfully in the more concrete form.

A further danger lies in the use of a general test for special vocational fitness. To a limited extent, this is justifiable: for gumption is valuable in all vocations, and a good intelligence test does test gumption. But the general test tries out, chiefly, what I have called the core of consciousness, and special vocational ability often lies in traits outside that core. So we hardly expect the general test to determine whether one is, or can be,

a good typist, musician, farmer, blacksmith, or social worker. But the general intelligence test should yield us two results even here. (1) Other things being equal, he will be best in any vocation who has the highest general intelligence. It is worth while—and the effort is being made—to have intelligence scales carefully worked out for each vocation, to accompany and supplement the special tests for special abilities. (2) General intelligence, among novices in any vocation, should be, on the whole, a good index of rapidity of improvement and final limit of development.

It may be objected that testing in the army has tumbled into the very pitfall here pointed out, of applying a general test to find out the fitness of a man for the special vocation of soldiering. But soldiering is not mere gun-pointing and trigger-pulling: it is a multiplex and all-inclusive vocation, involving nearly every kind of activity found in civilian life and some besides. Soldiering is full of general situations that require general intelligence.

There is a third danger which is just the opposite of the second. It lies in passing from a specific test to a general conclusion. Strangely enough, even some who deny the efficiency of formal discipline, seem to accept the efficiency of formal testing. For example, they assume that they have tested "memory" when immediate memory span for *numbers* has been tested, or that they have tested "attention" or "perception" by having the subject cancel all the A's out of a page of pi. A fourteen-year-old girl whom I once taught never did remember the multiplication table, yet she could easily catch complex pieces of music, retain them, and play them from memory.

We test what we test; but just how much more we measure, in the *mass* of subjects, we must find out by calculating correlations. And in the *individual*, nothing but complete, exhaustive probing is adequate. Here is further justification for the employment of several sub-tests as components of a complete general-intelligence test.

Finally, we must guard against giving a test, standardized by extensive mass methods, too close an intensive, individual application. Whenever we apply a standardized general test to any assemblage of complex parts, such as an automobile, or a horse, or a brain, we are sure that we can divide any collection of such units into grade groups, ranging from high grade to low. But any particular machine or animal or brain may hold up or break down contrary to our prognostication, based on the test. For this reason, we should make haste slowly (to avoid making progress backward) in establishing dividing lines that cut

sharply. It is taking too much responsibility to say that positively no one who can not make a certain average-to-high numerical grade in an army intelligence test is fit to be an officer —or a president. If Hughes had tested out higher than Wilson —why not give all candidates for office an intelligence test?— would it, and should it, have changed any votes?

With regard to testing in the army, two large questions arise:

1. Can we measure the intelligence of army men?
2. What military value has such a measure?

When a man enters the army, he is tested in practically every part: there is a board to look after his bones, muscles and joints, a heart board, a lung board, and so on. At length appeared a brain board, so to speak, the Neuro-psychiatric Board. Certainly there should be a board to pass upon the nervous system, for it is the controlling system of the body. Though all other organs be sound, they will be ineffective without a good governing system.

But all these various boards give, in general, a yes-or-no judgment, "good enough for service," or "not fit for service." They do not measure *degree* of fitness. Their attention is not so much on the normal as on the abnormal, and their chief effort is to keep that abnormal out of the army (or, if possible, to improve it sufficiently to serve). The neuro-psychiatrists aim to eliminate the neuro-mentally abnormal.

But now appears a new board, the psychological board, more accurately, the psychometric board, whose fundamental propositions are (1) that intelligence can be measured and graded; and (2) that grade of intelligence is so important that placement in the army should be made accordingly. An interesting innovation, surely; for nowhere else are all recruits measured and graded, beyond the yes-or-no, accepted-or-rejected plan, except in the Personnel Department, and not even there by such exact, objective standards. If the two propositions above are true, they fully justify the use of the increased space and personnel which the Psychological Board uses as compared with other boards which do not attempt such measurement, and fully justify also the total expense of psychological examining as the price of effective classification and placement.

With regard to the possibility of measuring intelligence, two extreme views are found. The first is, that it can be read off so readily from the subject's face, walk, etc., that there is no need of further measurement. The second is, that it can not be measured at all! Those who take the first view can usually be convinced out of it by actual trial—if they are game enough to

make one under controlled conditions. They succeed about as well as did the three teachers who were asked by Binet to estimate, off-hand and independently, the intelligence of each of a group of children. It is recorded that the three sets of results showed hardly any agreement.

Intelligence can certainly be measured. The only question is, How accurately? Here, it is only possible to mention a few of the lines of evidence which give the psychometrist faith in his results. (1) Certain tests have already enabled us, in civilian life, to predict educability, school progress. (2) The psychometric rating agrees fairly well—and too close correlation would arouse suspicion—with the rating of intelligence as given by officers who know their men thoroughly by long contact. (3) Officers, "non-coms" and privates show three very different averages, in the order mentioned, and three distinct, characteristic curves. (4) Racial difference stands out as previous investigations would lead us to expect. (5) The lowly-educated, who have had limited opportunity, sometimes surpass the more highly educated, which indicates that we are measuring innate ability rather than conventional education. (6) Repeated, independent measurements, give harmonious results.

By setting men at various tasks which test the heart, lungs, muscles, and so on, we can get a gauge on their general physical efficiency. By setting them tasks which tax perception, memory, understanding and the like, we measure their mental (intelligential) efficacy, can try out the running gears of their intellects.

Now for the second big proposition, which I think we can state, in extreme form, in this way: Granted a passingly good physique, intelligence is thereafter the most important factor in military efficiency.

It appears to me that neither the yes nor the no of this can be proven at present. The practical importance of intelligence in every-day situations is brought out by the much-repeated injunction to "Use your head!" On the other hand, our tests do not go far in measuring response to *social* environment. There are many cases in daily life where one is impressed with the truth of the adage that "Good nature is worth more than good sense." Line officers sometimes place on intelligence a lower value than we would expect, emphasizing rather such qualities as loyalty, obedience, adaptability and dependability. If you insist that a regiment should be balanced on the basis of intelligence, placing the same amount of it in each company, the line officer might reply that he wants it balanced according to discipline, or courage, or initiative. That the superior intelligence

of man has been the decisive factor in placing him at the head of the evolutionary race seems extremely likely. And Terman states that "with the exception of moral character, there is nothing as significant for a child's future as his grade of intelligence." Yet intelligence lies largely in the upper, most recently evolved, most delicate portions of the brain. It may be a very significant fact that, although the ratio of officers to men at the front is about 1:30, and among the wounded 1:24, yet among the patients admitted to special hospitals for war neuroses in England during the year ending April 30, 1917, the ratio of officers to men was 1:6. This may be due to the greater mental strain which falls on the officer, or to the fact that his more intelligent, and probably more sensitive, delicate nervous system, suffers shock more easily. If the latter, it is a question as to whether highest intelligence means greatest military efficiency under the most trying conditions. The answer to this question lies in France.

However, there is an interesting and closely related problem which the military psychologist should undertake to work out on this side of the ocean: To what extent is intelligence correlated with general military efficiency as displayed in our military life? To test this, we measured at Camp Meade, the intelligence of 765 men of the 17th Infantry (Regulars), all of whom had been at least several months in the service, and under the same officers. These officers were then asked, without seeing our grades, to rate their men, not as to intelligence primarily, but as to "*military efficiency*, which means *practical soldier value* to the army, all things considered." In estimating military efficiency, the officers were told to "keep in mind such points as dependability, judgment, discipline, comradeship and initiative." Five grades of rating were used, both by the psychological examiners in measuring intelligence and by the officers in grading military efficiency.

The results show that in 49.5 per cent. of the total number of cases, the intelligence rating and rating for military efficiency were the same; in 38.9 per cent., there was a difference of one grade only between the two; in 11.0 per cent., a difference of two grades; and in 0.7 per cent., a difference of three or four grades. If we leave out the last five companies, which reported tardily, and whose commanders, we suspect, took the experiment less seriously, we find the two ratings in perfect agreement in 52.7 per cent. of the cases, within one grade of each other in 36.5 per cent. more, and agreeing within two grades in 10.2 per cent., or practically all remaining cases.

Such experiments should be repeated to find whether they

prove the implication of the present one, namely, that if we place a man according to his intelligence rating alone, we shall have placed him, in the great majority of cases, substantially according to his military efficiency, his general camp value. It appears reasonable to suppose, until facts from the front prove the contrary, that camp value and trench value, enemy-killing value, are closely coincident.

At this point, we pass the question of placement on to our military and social leaders, to generals and statesmen. It is our work to discover the intelligence of the division, to point to the heads that hold it: the commanding general must determine where, in his organization, it shall be placed, whether it shall be concentrated in machine gun companies chiefly, or in the ambulance train, or whether it shall be distributed uniformly throughout. Further, our statesmen and other social leaders, taking counsel with the eugenists, must decide to what extent the winning of the war demands the exposing of the most intelligent portion of our general population to the highest mortality.

General intelligence, then, while it is not the only quality that makes a man valuable, is not only highly important for its own sake, but is, in the mass, bound up with other qualities which make for military efficiency. In individual cases, the intelligence rating may prove to be an inexact index of a soldier's general value; it may even go agog as an accurate measure of his intelligence itself, owing to his peculiar condition when tested, or to the too particular application of a general method. But that psychometric methods and measures have a high value for army purposes there is no doubt.

Officers are to be chosen for training camps; a corps of quartermaster's clerks or personnel assistants must be selected; in our haste, we must sometimes choose "non-coms" overnight; the feeble-minded must be eliminated; the Depot Brigade holds several hundred illiterates who are to be divided between an infantry regiment and a labor battalion, according to their native ability to respond to training; the commanding general has a company of uneducated thrust into his division shortly before its departure and wishes to know whether their intelligence warrants taking them to France; the development battalion is swarming: who of the swarm can be successfully developed and sent back to the line, and who should be rejected? Companies, regiments, whole armies are to be balanced, for the saving of time in training, for the just rating of the officers responsible for them, and, most important of all, for effects in the field.

Wherever appear the problems of mental classification and placement, there the psychometrist can be of service.

THIS GENERATION CAN NOT ESCAPE PAYING THE COST OF WAR

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WHAT are the "costs of war"? The answers to this question will depend upon the angles from which the great problem is attacked. The wastes of fighting impress different observers according to their individual outlooks and bulk large within each particular range of view. Perhaps the chief matters of concern in such an inquiry lie in the fields indicated by three topics: (*a*) The human costs, (*b*) The cost in materials, (*c*) The cost in money. The subdivision of the subject should not convey the impression that the parts are unconnected or sharply marked off one from the other, but rather that the whole theme will be easier of comprehension if the parts are considered one at a time.

1. The Human Costs of War

The pen halts at the thought of recording the human costs of war. The broken bodies and the shattered minds, the pains and anxiety, the horrors and despair, the wrecked relationships and the accumulations of hate, the benumbed hearts and the seared souls, all that the soldier endures at the front, and carries through life with him if he returns, all that his friends and relatives bear while he is away and bend under if he does not come back: all these costs are too many and great to be numbered. Of this, the greatest cost, only the least may be said. The words are too few and the expressions are not strong enough to tell the story of human sacrifice forced upon the people of this generation by the raging conflict. This burden can not be passed on to future generations. Whatever human losses are transmitted as an inheritance to the people of to-morrow do not lessen the burden of to-day. They add to the unreckoned human costs of war.

2. The Cost of War in Materials

The materials consumed in warfare are the product of toil and sacrifice and may not be too independently considered as distinct from the human elements of the problem. Men and women have changed the current of their lives and undergone

risk and strain second only to those of the soldier in order that the latter might be properly equipped for the direct conflict with the foe.

The materials now devoted to the purposes of war are largely the product of current efforts. Not a great amount of goods and equipment have been carried over from the stocks of past years. Little can be obtained at the expense of the future. What men are to fight with in the immediate struggle must be turned out here and now.

Upon their entrance into the war the different nations were possessed of varying amounts of military and naval equipment. But much of this original outfit has been destroyed and must be replaced by current products. Germany has turned some past products to present account as in the cases where copper roofs and church bells have been made into instruments of destruction. But the accumulations from earlier years can do little for the fighters of to-day. These stocks and stores have been quickly dissipated, with the increasing needs ever demanding more and more.

In a sense the future can be drawn upon for material help, but again the amount, compared with what must be secured, is not of great significance. During the war the wear and tear on machinery, factories, railways, buildings and other durable goods may be allowed to go on to an amount unusual in time of peace, though not to a degree that would interfere with operating efficiency. By allowing this permissible amount of depreciation to take place, the labor and material that otherwise would be used for repairs and replacement could be turned to the production of munitions of war. As a result this war material would be produced at the expense of the future to which would be handed on an equipment in capital and durable consumption goods of less effective character than otherwise would have been the case.

After all possible allowance has been made it is only too clear that the materials of war must be made as the struggle goes on and that the people of to-day must pay this cost by increased labor and saving. This burden of providing the enormous quantities of munitions and supplies is as imperative a daily, current duty as is the service of the soldier in the trenches. It can not be put off nor escaped. The soldiers of to-day fight with the products of civilian laborers of to-day. The costs of war in materials must be paid by this generation, it can not be passed on to the future. This fact is so simple, clear and plain that multitudes of people do not realize its significance. The the real economic direct cost of war. It must be met here and

now. No methods of combining note issues, bond sales, and production of the material equipment for the fighting force in taxation can alter the situation. While the fighting is on and not after it is over, must the civilians work and save to make the needed goods. The economic costs of reconstruction when peace comes will be additions to the costs of war, not payments for it nor reductions in the expense.

The call to work and save is as immediate and pressing as the call to fight. Neither can be escaped nor postponed.

Saving is important because it releases labor and material from civilians' uses and turns them to the public service. The spender in essence asks people to work for him or furnish material for his own satisfaction. On the other hand, if he saves and turns his funds over to the government he gives to his country the power to secure this labor and material for public defence while he foregoes its private enjoyment. Saving thus increases the materials available for the army and navy. Saving and increased production both will have to be pushed farther than ever in our past experience if through this war we are to win a durable peace. Greater saving and greater exertion in making equipment must precede the fighting not follow it. The cost of war in terms of goods must be met to-day. It can not be passed on to succeeding generations.

3. The Cost of War in Terms of Money

In earlier times when wars were fought with little money and no credit paper the basic costs in human pains and in materials were outstanding. The fighters and their generation paid these costs with little chance of misunderstanding in respect to who were the real bearers of the burden due to the struggle. In later days when governments issue paper money, sell bonds and collect taxes the situation has become complex and a great deal of confusion has arisen concerning the ultimate effects of the different methods by which the costs of the war in terms of money may be paid. Some of the difficulties seem to be due to an inability to examine the matter from the same point of view or to hold to a given angle throughout the discussion. The effect of a given policy on individuals, on economic classes, and on successive generations is not likely to be clear unless one keeps in mind the specific part of the problem that is being considered.

The principal methods through which money for war purposes may be obtained are six in number:

1. Requisitions in occupied territory. Germany's practise in Belgium serving as an example.

2. Indemnity from a conquered enemy. Germany's policy at the end of the Franco-Prussian War and at the beginning of this war.

3. The profits of state-owned industries, as the German railways or the mines of England as suggested by the Fabian socialists.

4. Issue of paper money, as the greenbacks in our Civil War and Germany's present issue, disguised though they are as issues of banking institutions.

5. The sale of bonds to be paid for by taxes after the war.

6. Taxation during the war.

The following discussion will concern itself with the consideration of the effects of the second three methods of raising the money needed for war purposes.

The issue of paper money and sale of bonds are alike in that they are both loans, though very different in that the note issue is a forced loan that inflates the currency, while the bond purchase is a voluntary transaction that does not necessarily produce inflation. All three are alike in that the taxpayers have to foot the bills, though collection is postponed in the case of the first two. Bonds and taxes are alike in that the bond buyer and the taxpayer must turn over the money to the government at once, though what is received for the money, a bond in one case and a tax receipt in the other, differ widely. Furnishing the money, like furnishing the men and the materials for war can not be passed on to later generations. All three must be provided now by the people of to-day. Whatever may come back in the future does not alter the fact that all three, the money, the men and the materials must be given up by the people of the present if there is to be any future worth looking forward to. An examination of the differential financial expedients for putting the government in funds will indicate the characteristic features of each one and the economic consequences of its employment.

A. *The Issue of Paper Money.*—This is the easiest way, but the suggestion of its adoption is the counsel of folly or despair. Our experience in the Civil War and the bitter lessons from other times and countries ought to keep us from repeating the monumental blunder of financial incompetence. Just now the thing seems improbable, but if the war is drawn out to great length and the financial load grows steadily greater, some belated financier will probably arise and tell us of a burdenless way of paying war expenses by running the printing presses.

When a government issues paper money and compels its citizens to accept its notes in payment for goods and services,

its action amounts to a forced loan without interest. But this forced loan differs from an ordinary loan in that the citizens' purchasing power is not diminished as it is when money is handed over to the government in exchange for bonds. In the latter case the lenders turn over part of their power of buying to the nation and to that degree take themselves out of the market. The demand for goods is transferred from private to public hands, but it is not increased by the funds derived from this type of loan as such. To the existing supply of goods the usual demand is presented, except that it is made by the government instead of by private individuals. The result is that there is a minimum disturbance of the price level and the general business situation.

When a government issues paper money and goes into the market with it to buy supplies a very different result obtains. The government's new purchasing power is added to that of its citizens and the greatly increased demand presented to the ordinary supply of commodities drives prices upward at a rapid rate. The tendency toward higher prices, inseparable from the imperative needs of war, is greatly exaggerated and the whole business of the country is disturbed by an abnormal change in the level of prices. Ordinarily the citizens' increase in purchasing power is due to an increase in their productive efforts in making goods and the greater demand is matched by a greater supply of commodities, so that the exchange ratio is not altered and the price level is more or less constant. Not so with the increase in buying power acquired by a government through the issue of paper money. No simultaneous increase in output meets the enlarged demand and the existing stocks of goods are subjected to the pressure of normal private buying plus this abnormally created public purchasing power. The consequent rise in price favors a few and upsets the calculations of the great mass of citizens, with the hardship falling usually on those least able to bear it.

A second influence works in the same direction. A resort to paper issues is a confession of weakness and an evidence of incompetence. The first step is quickly followed by the second and the government is soon unable to redeem its notes in standard money. The country suspends specie payment and the paper dollar itself then becomes the standard money in which values are expressed. The paper standard fluctuates in value as compared with the specie standard according to the probability that eventually it will be redeemed in coin. The volume of the issues, the prospects of success in the war, and the chang-

ing policies of the changing officers in charge of the administration will affect the public's faith in ultimate redemption and hence in the value of the paper standard. The result of this fall in value and these fluctuations in the standard are rises and alterations in the prices of commodities due to no influence in the field of production or consumption but to unpredictable changes in the paper standard whose gyrations reflect an unhappy combination of the fortunes of war with the compromises and second choices of political and often partisan policy.

The unproduced purchasing power put in the hands of the government and the erratic paper standard in terms of which the prices of commodities are quoted lead to the type of experience described by Louis Blanc when he wrote of a French situation, "Business was dead; betting took its place." Rising costs of living lead to labor disturbances that cut down production. People with fixed incomes suffer hardship. The government pays the inflated prices for its war supplies, and the soldiers find what they can buy with their meagre pay marked by low visibility. The increased cost of the war falls upon the taxpayers when the bills are eventually passed to them and they have their perennial privilige of paying for blunders that should have been avoided. The country ought to set itself like flint against any suggestion of issues of paper money, directly or indirectly, that would lead to a departure from a specie basis. The war can be fought without inflation of the currency by the government or banks, just as the navy can fight without a ration of rum.

With this discussion of paper issues for the purpose of eliminating them as a practical policy we can turn to a consideration of borrowing by bond sales as a method of raising money in time of war.

B. *Borrowing by Selling Bonds.*—No nation is ever likely to put into operation an adequate taxing system upon the outbreak of war. A militant oligarchy hopes to pay the expenses of its adventures out of indemnities collected from the defeated enemy, while democracies will never be so prepared for war that they will have at hand a system of war taxes devised in advance and ready for immediate enactment when the crisis comes. But money must be secured at once. Resort is therefore had to the sale of bonds as the effective method for obtaining the required funds, usually preceded by issues of short-time certificates of indebtedness in anticipation of the proceeds from the bonds. Bonds have this very great advantage of the superior quickness with which they yield the required funds.

A second significant feature of bond sales arises out of the fact that their purchase is a voluntary action. Joined with this is the convenience in denomination and terms of payment. As a result citizens can adjust the amount purchased to their respective abilities in a fashion that will allow persons of modest means to turn over their savings to the government, as well as offer the opportunity to every other group in the country to advance the needed money in such measure as their resources will permit. By tapping each store in accordance with its contents the bond shows itself a flexible instrument by means of which the hidden wealth and unsuspected financial resources of the great body of citizens are made available for the public service. People voluntarily turn over to the government in exchange for bonds great sums of money that otherwise would lie beyond the ken of the tax-gatherer or that could be reached only by the most inquisitorial methods, which would tend to defeat themselves by arraying the ingenuity of the owners against the inadequate knowledge of the officers of the law.

The fruitful resource of bond sales is so effective because it unites the two powerful appeals of patriotism and personal profit. Citizens are urged to put their funds at the disposal of the government because the safety of the country and all they hold dear depends upon the expenditure of money in the public defence. They are shown that others are going into battle for the security of the citizens at home and that the soldiers' hardships are not even poorly matched by the pecuniary sacrifices that must be made by the civilians if the fighters are to be given the support with equipment, food, weapons and ammunition that they must have in order to discharge the duties to which they have consecrated their lives.

To this call upon patriotic feeling is added the prospect of economic advantage due to the safety of the principal and the payment of pure interest on the loan; that is, interest from which nothing need be deducted as insurance against risk or for care and skill in management. The probable premium on the bonds after the war is also an inducement. A much greater advantage is promised by the probable fall in prices after the war. If we assume that present prices are about fifty per cent. higher on the average than pre-war prices, then a dollar to-day will buy no more than 65 cents bought in 1914. If prices after the war fall to the pre-war level a dollar then will buy as much as a dollar and fifty cents will purchase to-day. The saver who chooses to buy a one hundred dollar bond to-day rather than spend $100 for current consumption is in reality choosing be-

tween $65 worth of goods now and $100 worth of goods after the war, measured on a peace-price basis. In other words $100 invested in a bond now will command when the bond is paid as many commodities as $150 will buy to-day. This is a real premium and a large one, overlooked usually because people think too much in terms of money and not enough in terms of goods.

Added to this gain after the war is another advantage that comes from saving now. Refraining from unnecessary buying for private use during the war reduces the demand for commodities and thus lessens the tendency of prices to move in an upward direction. People by continuing their usual buying compete with each other and the government in the purchase of goods. By this persistent bidding among private individuals and against the government the level of prices is raised all around and money spent does not go as far as before. On the other hand, turning part of one's outlay into bonds reduces this competitive demand, checks the rise in prices, and makes what one does spend for consumable goods able to get more goods in the market. Saving thus makes more saving easier by moderating the rising cost of living.

When it is evident that buying bonds combines these economic advantages of (1) safety of principal with (2) pure interest, (3) a probable premium on the bonds after the war, (4) an even more probable advantage of greater amount through a fall in prices when peace comes, with a consequent increase in the purchasing power of their savings, and (5) a tendency to mitigate the rise in prices during the war: when it is seen that these individual advantages are joined with the opportunity to be of public service, the combination of patriotism and profit places at the government's disposal great sums of money with remarkable speed, a result that is vital at the outbreak of war.

C. *Taxation in War Time.*—It has long been suggested that part of the prudent preparedness for war should be an outline scheme of taxation, drawn up in advance, ready to be filled in and enacted promptly upon mobilization. But for reasons indicated above this has never been done.

The process of enacting tax legislation is slow, considering the emergency to be met, and the result is likely to be a statute satisfactory to no one, oppressive to many, and unworkable in some of its parts unless supplemented or modified by administrative rulings. The crudities have to be hammered out on the anvil of experience.

With these disadvantages to be met, the returns from taxes come into the public treasure slowly, too slowly to furnish funds

for the great emergency, without the assistance to be had from bonds.

Along with this defect, taxation has the great merit of compulsion that is lacking in the case of bonds except so far as it is provided by the pressure of group or public opinion. Taxation forces many persons who are able to pay to do their patriotic duty whether they are willing or not. Much money that would not come to the help of the public voluntarily is reached by the strong arm of the law and drafted into the service of the country. There are so many varieties of citizens that no one method of reaching all of them is adequate. The government must go equipped with every possible collecting agency in order to get, by both persuasion and compulsion in their varied forms, all of the enormous sums that must be raised to meet the pecuniary outlays of modern warfare.

The rigid rules of the taxing machinery have an important rôle to play, though they have limitations in their effectiveness in raising funds. These rules must be general, broad in application, and inelastic in execution, applying to groups rather than to individual and special cases. They get with considerable effect whatever comes within their scope, but much of the country's resources escape beyond the limits of these laws. To reach the resources of some would require such rigor in the law that the burdens upon others would be intolerable, and the harsh rules would so interfere with the free play of business enterprise that the productive efficiency of the country would be reduced. While the limits to the amounts that can be raised by taxation can be greatly widened by education and experience, the policy takes time and can never hope to attain the bond's ability to reach individual capacity.

The tax-gatherer's task is made easier in war-time by the patriotic enthusiasm for the support of the fighting men. Citizens who are unable to go to the front find an outlet for their devotion to their country through tax-paying and the exchequer is enriched by the willing payments of many who find relief in the consciousness that their money is representing them in the raging contest. This war-time tax-paying impulse dies down when peace arrives and paying taxes for the discharge of war obligations takes on the character of paying for a dead horse. It behooves the finance officers, therefore, to collect while the collecting is easy and the taxes are fruitful.

There are some types of earnings that are war-bred in character, such as excess or war profits and incomes swollen through the increased business activity due to military operations and

the by-products of such enterprises. These temporary, increased incomes should be reached at once, because they will not be available if time is allowed to pass. Moreover, if they are reached quickly before the recipients have had them long enough to develop a feeling of possession in them, a larger fraction of such incomes can be taken, with less mental anguish on the part of the taxpayers, than would be possible if the process of sharing the new gains with the nation were longer delayed and time given for a vested interest to develop in this type of unearned increment. Prompt, vigorous taxation of war profits or excess profits due to war business, direct or indirect, will make it clear that these gains are due to the general situation and not to exceptional industry or management on the part of the recipients, and that they are not in origin or character to be regarded as private property.

Considerable difficulty is encountered in those cases where businesses must be extended in order to produce supplies necessary for the conduct of the war. No ordinary profit would justify the construction of plants whose product would be without a market should peace suddenly come. Here it would be better not to make the extension on the basis of a speculative, private enterprise but to have the government underwrite the risk involved in the additional investment as a public expense.

The excess-profits tax bristles with difficulties, but these must be met in order that the rich revenue it will produce may be secured in this time of exceptional need.

The Relation of Bonds and Taxes in Distributing the Cost of War

From what has been said it is evident that as a matter of practical, sound finance both bond sales and taxation must be employed in order to get quickly and in adequate amount the money needed to pay the cost of war. The debatable question is the proportion of the income that should be raised by each method.

One of the curious and widespread illusions respecting the advantage of raising funds by borrowing instead of by taxation is to the effect that through the later payment of the loan part of the money cost of the war will be passed on to future generations. It is evident, as indicated above, that this generation furnishes the money required for war expenses, whether it is raised by taxation or by bond sales. The taxpayer gets back a tax receipt while the man who lends to the government receives a bond, but both have handed over money to the public treasury.

This generation has put up the hard cash. When the bonds come due and future taxpayers furnish the money to pay the obligations, to whom is the money paid? To this generation which gave the government money for the bonds? Assuredly not. This generation will have gone to its reward by that time and the taxpayers of the next generation will pay the bondholders of the next generation, not the bond buyers of this generation. As long as the problem is considered from the point of view of the mass of the people described as "this generation" as contrasted with future generations, there is no doubt that "this generation" must furnish the men, materials and money needed to win the war and that it will be impossible for the people of to-day to collect anything in return from the people of to-morrow. It is when the problem is approached from the angle of the interests of individuals or economic classes that the difference between taxes and bond sales becomes of significance. In these relations it is possible to pass the burden to others in case of bond issues when it would not be possible should the money needed be collected by taxation. The significant facts from these angles may be made to appear in a few simple suppositions.

For the purpose of illustration let us suppose that (1) the entire cost of the war were met by selling bonds and (2) that all citizens were able to buy the same number of bonds and (3) that the bonds were eventually to be paid for by a poll tax of so much a head, assuming "that all other things remain the same." If each citizen bought a $1,000 bond and later paid $1,400 in poll taxes to cover the interest and principal of the bonds, the effect would be essentially the same, apart from the cost of administration, as if the burden had been met by taxes during the war. Each citizen would have given up at once $1,000 in either case, receiving a bond in one instance and a tax receipt in the other. Were the bond method chosen the government later would reach into the bondholder's right-hand pocket for taxes and pay into his left-hand this same money as interest and principal. If the bonds ran for a long time the same relation between taxpayers and bondholders would continue, paying and receiving would balance each other. There would be no choice between bonds and taxes as methods of raising money.

If the bonds were unpaid for fifty years and the generation of buyers passed away and a new generation inherited the bonds and the obligation to pay taxes, the case would not be altered. This earlier generation would have turned over the money to the government and passed on the bonds to its heirs, who would

pay off the bonds with taxes, but this earlier generation would get none of the money. The future taxpayers would pay the future bondholders and in this supposed case no one would be ahead or behind, seeing that bondholding and taxpaying are assumed to be equal for every citizen. The original bondbuyers might as well have paid taxes as bought bonds. It is of no particular advantage to pass to one's heirs an asset like a bond if it is accompanied by the equal liability to pay taxes.

This supposition of equal power to buy bonds and pay taxes is too far removed from reality to serve for more than an illustrative point of departure. Imagine that the citizens are classed in groups according to their ability to buy bonds, *e. g.*, in the relation of 1, 5, 10, 15, 25, etc., and that they are assessed for taxes in a similar ratio. This might be nearer the real situation, but it is still evident that they would have to give up the price of the bonds at once upon buying them, and that later they would be taking out of one pocket to pay taxes the money would be returned to the other as interest and principal on the bonds, leaving them neither richer nor poorer.

These suppositions are intended to illustrate what is perhaps evident upon mere statement, that there is no advantage to the individual in the policy of public borrowing rather than in pay-as-you-go taxation if his purchase of bonds as an investment is matched by an obligation to pay taxes later in proportion to his holdings of bonds. He might as well accept a tax receipt at once for his money as to get a bond that he must later pay off himself by turning over money for tax receipts. He gives up cash at once in both cases and his later income from coupons and final payment when the bond system is adopted are matched by his payments of taxes. When later taxation is proportioned to bond purchases it is an illusion to think of the bond as worth more than a tax receipt. All of this is based on the assumption that the purchaser of the bond holds it until maturity or passes it on to his heirs.

But it may be objected that the bondholders can sell their bonds, whereas there is no market for tax receipts. If the money were reinvested the new income would be reached by our supposed system of taxation according to ability. If the price received from the sold bonds were used in untaxed consumption the seller would be in the group indicated later who would find advantage in the system of public borrowing rather than in taxation.

There is no escape from the conclusion that if the people generally buy bonds according to their ability and are taxed ac-

cording to their ability to pay the interest and principal of the bonds, there is no advantage to any one in the purchase of bonds rather than the payment of taxes during the war.

If one should turn an abnormally large proportion of his property into bonds would the situation be changed? Not at all, because he would lose the higher income that might have been gained in other fields as an offset to the income from the bonds. On the other hand, buying no bonds or relatively few would not give any one an advantage. His investments in other fields might yield a larger gross return but if the taxes, as we are supposing throughout these illustrations, were actually adjusted according to ability to pay, these higher returns would be reached by the tax-gatherer and no advantage left to the holder of individual or corporate investments as contrasted with the owner of government bonds. The taxes paid by the former would be paid to the latter until the national debt were paid.

In all three of the supposed cases, whether one buys bonds according to his ability or more than the normal amount or less than could have been expected, there is no gain to individuals in the bond system as compared with taxation during the war, provided the taxes after the war are collected according to the citizens' ability to pay and the individuals and their heirs continue in the same classes as far as taxpaying ability is concerned. If every individual retained the same relative economic rank and were obliged to pay taxes according to his ability after the war he might as well pay taxes during the war. When either of these conditions does not exist there enters the possibility of individual advantage when the government raises money by selling bonds rather than by collecting taxes at once.

The persons who would gain directly by the bond system would be chiefly the ones for whom postponed taxation would mean escaped taxation: the recipients of war profits or enlarged incomes during the war, the citizens who would be saved from consumption taxes during war and thus be able to buy commodities cheaper, those who would be able to escape their proportional burden through the character of the tax system adopted after the war. The essence of the matter is to be found in its effect upon the ultimate resting place of the burden of taxation. Bonds make it possible to redistribute the cost of war among the different economic classes through modifications of the tax system or the opportunities to avoid its pressure that might give results after the war of a kind which would not be possible during the conflict. A statement of some of the possible combinations of bondholding and taxpaying will suggest

the possibilities of thus shifting the burden of the money cost of the war among the different groups of which the nation is composed.

It would make a significant difference in determining who would pay the cost of the war if in constructing the revenue system a strong preference were shown either for taxes upon articles of common use or for direct taxes such as income, inheritance and excess porfits taxes. If the money to pay interest and principal of the bonds were raised by taxes on sugar, coffee, tea and other staple consumption goods, either through internal taxes or tariff duties, the cost would fall upon the ordinary citizen with a weight exceeding his relative ability to pay. If the bonds were widely held the mass of the people would go through the experience of paying higher prices for the necessaries of life in order to get back the money they had advanced in war-time. An increase in the cost of living would be required to pay the war debt, one offsetting the other, but the mass of the people would be out the original purchase price of the bonds.

On the other hand, if the tax system were one largely of direct taxes and the bonds widely held, the burden would be thrown upon the well-to-do groups while the redistribution of the receipts from taxes as interest and principal of the bonds would increase the income of the mass of the people at the expense of the richer taxpayers. It would amount to this: that whatever money people of modest circumstances advanced during the war would be repaid to them with interest by their wealthier fellow citizens and the general tendency would be to reduce the inequality of the economic classes in the nation.

A very different situation would result if the bonds were held by the relatively few people of large fortune and the taxes were collected by tariffs and excises on staples. The mass of people of lesser fortune would pay the bulk of the taxes and the money would flow to the stronger economic groups as interest and principal, with the consequent increase in the inequality of possessions.

To suggest another possibility, the bond system might be combined with post-war taxation in a way that would keep down the burden of taxation for the mass of the citizens during the war by making it possible to forego general consumption taxes on staple goods. Taxes on incomes, inheritances and excess profits might be supplemented by bond issues during the war and later the war taxes be continued in peace-time until the bonds were paid off. By such a plan bond issues would aid in placing the money cost of the war upon the shoulders of the

recipients of the larger incomes regardless of who bought the bonds originally. If this group bought them they would have advanced the money during the war and paid themselves off after the conflict. If the people of modest means purchased the bonds from the government they would have advanced the money during the war and would be reimbursed out of the receipts of taxes paid by the stronger group.

Without exhausting the possible combinations of bonds and taxes doubtless it is plain from these perhaps over-sharply contrasted comparisons that the effect of bond issues is largely determined by the type of taxation finally resorted to in order to pay off the obligations. The issue of bonds postpones the resort to taxation, an advantage in some cases, but its chief ultimate result lies in the possibility of redistributing the money cost of the war among the economic classes of the nation, not in passing it to future generations.

Looking at the matter from the limit of unpatriotic meanness, it may be said that to the degree to which one may hope to escape paying the taxes that will have to be laid after the war to cover principal and interest of the bonds, to that degree he may logically favor bond issues that will enable him to escape taxation during the war. As long as there is the chance that the post-war taxing system will bear less heavily upon some citizens than upon others, as long as there is the expectation that individuals not now able to pay much in taxes will later grow into the heavy tax-paying group; as long as individuals through losses may need to turn bonds into money for current expenses and through reverses decline in tax-paying power, so long will it seem more advantageous to individuals to give their money during the war for bonds rather than tax receipts. The key to the situation is not that this generation is not able to pay the money required to carry on the war (it must do that), but that the purchase of bonds may permit the burden of finally paying the tax to be shifted to other individuals or to the heirs of others. An illustration may be found in the possible effect of immigration after the war upon the number and composition of the tax-paying body of the United States. If peace brings a flood of people from Europe they will divide the burden of taxation with the taxpayers now here and their descendants. In such case bond issues now would be effective in lessening the cost of the war to the latter group and their heirs, and in that degree be more advantageous than taxes during the war. On the other hand, if peace should send a wave of emigrants from our shores to Europe the loss of these potential tax-payers and

the probable industrial dislocation following the war would make tax-paying then to meet interest and principal of the bonds more difficult and borrowing would be the more burdensome policy in the long run. To strike a balance between these possibilities would require the peculiar foresight so glibly revealed by passing social soothsayers.

Bonds are an investment to all those who do not later have to pay taxes or a proportionate share of taxes to meet the interest and principal. To all others they are the means through which patriots may contribute to the support of the war and later wipe the slate clean by putting money into the government's vaults in paying taxes and drawing it out again by cashing coupons and eventually receiving the face of the bonds.

Lest there be misunderstanding it ought to be said that failure to buy bonds does not enable one to escape the burden of later taxation, whereas the thrift practised in saving to buy bonds will enable one later to carry the burden of taxation with greater ease.

If the bulk of the bonds are bought by that portion of the people whose incomes are above two thousand dollars and if the bulk of the taxes are paid by such persons in the form of income, inheritance, excess profits and corporation taxes, the burden of the war debt will be wiped out in the process of paying themselves with taxes that come from their own pockets. The real sacrifice in such case is made in buying the bond, not in paying it off. If the country can stand the burden in war-time, it need not worry about the load of debt in years of peace. The claims of the citizens against the government can be offset by the government's claims for taxes against the citizens and the obligations will cancel each other. The nation need not break down under the economic strain. Excluding the cost of collection, every dollar that is taken from the citizens after the war to pay the debt will be returned to the citizens. There will be no drain upon the country's resources of a wasting sort such as is experienced during the war. When the war is over its cost in money to the country as a whole will have been paid. Clearing off the debt involves a redistribution of a portion of the community's wealth among the bondholders and taxpayers, not a reduction of the country's assets.

Political sagacity and balanced economic judgment in distributing the burden of taxation will be the prime essential in the debt-paying period. The system of taxes then especially should be constructed with keen attention to those sound principles of finance that will least interfere with the fruitful de-

velopment of the nation's economic strength and most nearly meet the demands of equity and justice.

Looking at the question from another point of view, a comparison of the interests of the soldier and the civilian makes the choice between the policies of borrowing or taxation a matter of importance. The soldier has left his business and prospects of economic advancement to defend his country. The civilian at home enjoying in many cases increased opportunities ought to bear the money cost of the war. It is the least that he can do.

While it is true as indicated above that ultimately the difference between bonds and taxes is not as great as is commonly supposed, nevertheless the bond method carries the possibility of disadvantage to the soldier. When he leaves the ranks of fighting men he may find himself conscripted into the army of taxpayers who will be obliged to pay off these bonds at a later date. Every claim of fairness, decency and patriotism demands that the civilians shoulder the financial load now by taxing themselves to cover the largest practicable portion of the war expense, willingly yielding their money as others are offering what is of infinitely greater value. No one should think of admitting to himself that he would prefer a bond to a tax receipt if the bond meant that in later years some one-armed hero would have to pay more for his taxed tobacco in order to pay interest on the bond. Cutting the coupons from such a bond would blister the owner's fingers.

Admitting, as has been done, that bonds are an indispensable adjunct to war finance under existing conditions, nevertheless the soldier has the right to call upon the civilian to pay taxes to the utmost while the war is on so that broken men will not come back to share in paying the money cost of that for which they have already paid in pain and sacrifice while they reflect with bitterness upon the ingratitude of civilian slackers.

In their effect upon the saving that turns men and materials from individual to national service bonds and taxes will differ with individuals. Persons who could not well be reached by taxes will find the appeal of the bondseller convincing, while others need the compulsion of taxation to make them change their habits of consumption and release for the public good what they have usually consumed in private enjoyment. The feeling that the bond is an investment leaves many owners with the idea that they have provided for their future and may therefore spend freely in the present. They forget that bonds are but the evidence of postponed taxation. On the other hand, the taxpayer is subject to no illusion. He knows what has happened

and, finding himself deprived of his money, is in a mood to restore his depleted assets by saving. He is more open to the appeal for patriotic thrift than is the complacent bondbuyer who has parted with anything like the same amount of money. It is altogether probable that the pressure of taxation is more likely to bring home to the thick-skinned the need for private economy than is the opportunity for the purchase of bonds.

The relative effect of the two methods of finance upon the level of prices is closely connected with their effect upon saving. If bond buyers paid for their securities by cutting down their expenditures and investments, and taxpayers met their tax bills in the same way, the purchasing power of both would be transferred to the government and, so far as demand is concerned, there would be no inflation of prices from either source. Demand that was formerly private would now become public, but its total would not be increased. Its direction would be changed and prices of commodities needed in relation to national defence would be raised while other goods would fall off in sales. Such changes are not to be called inflation. They are part of the process of turning the forces of production from non-war to war industries and are necessary as long as the government does not resort to a policy of industrial conscription and the civilians hang back in the readjustment of their lives, while they cheer on the boys who are offering theirs to the country; the civilians who keep the home fires burning under the flesh-pots of their old desires.

While it is conceivable that neither bond issues nor taxation necessarily leads to inflation, it is probable that in practise bonds lend themselves more readily to produce such a condition than do taxes.

What is inflation? Ordinarily an increase in purchasing power comes from an increase in the production of different types of goods. These can be sold and the money received used to buy other goods. That is to say the increased demand for goods arises simultaneously with an increased supply, the two offset each other and the price-level is kept about as before. When a good harvest enables the farmers to send agricultural products to the cities as demand for factory-made goods and the enlarged supply of factory products makes an increased demand for the farmers' output, brisk business may be transacted with no particular change in the price level and with an increase in general well being. The food sent in by farmers as "demand" for implements helps to create the supply of implements, while the implements sent out to the country as "de-

mand" for food aid in the production of the supply of food. On the other hand, the essence of inflation is the creation of purchasing power or "demand" without the creation at the same time of goods or "supply." Enlarged "demand" arising outside the current productive processes is not balanced by greater "supply" and the pressure of an increased buying power upon the ordinary stock of goods drives the general price-level upward to an inflated stage.

The agency through which purchasing power may be thus abnormally swollen is credit, either in the form of paper money issued by a government or loans by commercial banks on securities based on something else than saleable commodities already in the channels of trade.

When a government issues its paper money it goes into the market and uses its notes to buy in competition with and in addition to the buying power of its citizens without increasing the amount of goods to be sold. Thereupon prices move upward. The issue of paper money is an indication of weakness and is in fact a stride toward suspension of specie payment. The metal standard money is supplanted by the new paper. From then on prices are expressed in the paper standard. The value of this money changes with the prospect of its redemption in coin so that the new high level of prices moves up when the prospect of redemption is lessened and down as the outlook improves, as has been pointed out earlier.

In the second case when the inflation comes as a result of extensions of bank credit it may be brought about by the issue of bank notes or by the granting of deposit accounts against which checks may be drawn. The current level of prices in normal times is adjusted to conditions in which bank loans are made freely on credit paper arising out of commercial transactions that have but a short time to run. Increasing the volume of loans of this character does not inflate prices because the increase in purchasing power made available merely meets need for it due to the greater supply of saleable goods. When, however, commercial banks, that can safely lend their credit only to facilitate commerce in the form of short-time loans, begin to lend on securities that do not arise out of current buying and selling such as government bonds or other types of investment such as constantly renewed notes of governments or investors, the danger of inflation is at hand. The purchasing power that is thus created abnormally increases the power to demand goods with no accompanying increase in the supply of saleable commodities and the price level rises. The process amounts to coin-

ing capital into money. It acts as would a huge addition of gold to the existing stock of money if it could be made without an expenditure other than the stroke of a pen. It lowers the value of the standard and hence raises the price level.

These extensions of credit do not cause higher prices; rather they permit the powerful war demand to express itself in more compelling terms in attempting to call for quicker and greater production of essential articles. More dollars are offered as a premium for speed and volume of output. The value of dollars thus falls in relation to goods and the new relation is expressed by the inflation to a higher level of prices that spreads over the whole field of buying and selling with all the painful adjustments that are involved. The evil is an unnecessary one and adds to the cost of the war by raising still more the prices that the government must pay for supplies; prices that are high enough for unavoidable reasons of increased cost of production without adding inflated credit to the list, and these higher prices mean heavier issues of bonds or more taxes. Eventually the taxpayers have to foot the bills when the bonds are redeemed after the inflation has subsided in time of peace, and the prices of labor and commodities are lower. It has been authoritatively estimated that the inflation of prices due to the greenbacks of the Civil War made the war cost the taxpayers $600,000,000 more than it would have cost had the country kept itself on a specie basis. The inflation due to bank credit is similar in its consequence.

Because bonds lend themselves to this type of extension of credit, their existence in large amounts tends to inflate prices. They have even been used directly in the purchase of commodities when business houses in a mistaken spirit of patriotism have offered to accept them in exchange for goods.

While as stated before it is to be conceded that bond issues do not necessarily lead to inflation and a higher level of prices, it is so easy to tread this primrose path to torment that the prospect is sufficient to make a restraint upon unnecessary bond issues of real importance.

Another problem of some complexity is emerging with each additional issue of bonds and is certain to become more serious if borrowing is given too large a place in our war finance. The threatening trouble arises from the fact that the rate of interest offered on bonds is below the market value of loanable funds to many investors, on the one hand, while, on the other, it is not possible to increase the rate without creating a form of investment that would lead to serious and disturbing competition with sav-

ings-banks deposits and investment securities, to say nothing about the great increase in the eventual burden upon taxpayers. There are indeed many persons to whom the bonds at the present rate are attractive as investments and many others whose patriotism can be counted upon to make the financial sacrifice involved in buying the government securities whatever the rate of interest. If the rate of interest is to be kept down the bond issues should be held within the limits of the purchasing power of these classes and taxes be relied upon to make this possible. Taxes laid upon business would tend to lessen the excess gains of industry and hence act somewhat as a restraint upon the rate offered for loanable funds for industrial and commercial purposes. If there were less opportunity for huge war profits borrowers for business extensions would not offer such high rates of interest on capital, with the consequence that the government and business generally would not be compelled to borrow upon such unusual terms in competition with abnormally stimulated types of industry and trade. Increasing the proportion of war revenue from taxes and lessening the amount raised by bond issues will thus make it easier to sell bonds at a moderate rate of interest and enable us to avoid an injurious disturbance of values in the field of savings and investment that would add to the burdens of the war.

The outstanding conclusion in this consideration of some of the principles of war finance is that the costs of war in men, material and money are present costs that cannot be saddled on the future.

Pay-as-you-go taxation is the logical way to carry the present money cost, but it is impracticable as the sole method because it does not yield fast enough and has never been sufficiently developed to reach fully individual capacity to pay. It must be combined with bond sales to get at once the desired results. The latter yield large sums because of their appeal to patriotism and personal profit. The latter idea of an investment with a net return is true for the individual when the bondholder is not obliged to pay proportionate taxes later for the redemption of the bond. In case he must do so the bond is not in reality superior to a tax receipt gotten at once, though it does rank with any other investment whose returns are destined to pay taxes, and all investments now being made are likely subjects for future taxation. However, the future is so uncertain and the general run of citizens so little given to looking forward that most people regard the bond as an investment. As a result the psychological strain of raising huge sums is greatly reduced.

The bond method in addition allows more latitude in the adjustment of taxation in and after the war than would be possible in case all expenses were paid by taxation during the conflict. This possibility of redistributing the financial cost of the war among different persons by the particular system of taxes adopted makes it important to give attention to the types of taxation chosen both during hostilities and when peace comes, in order to make the whole scheme meet the demands of equity and justice.

The presumption in favor of vigorous taxation in war-time is strengthened by the patriotic willingness to pay taxes while the struggle is on, by the increased ability to pay of many with enlarged incomes, by the temporary character of some of these larger incomes that makes it desirable that they be reached at once, by the fact that returning soldiers should not be compelled to face heavy taxation to pay interest and principal of bonds owned by civilians, by the probability that in many cases taxation is more effective than bonds in leading people to save, and finally that bonds are likely to be the basis of inflated credit which will raise prices, while their excessive issue with the necessary higher rate of interest will introduce a disturbing factor in the field of savings and investment.

The sum of these considerations of war finance is this: the largest practicable portion of war expenses should be carried by taxation while the war is being fought, and the issue of bonds be kept within the limits set by necessity.

THE ETHICAL VALUE OF SCIENCE

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THE object of scientific study is to learn all that we can concerning ourselves and the universe in which we live, with the aid of the senses and reasoning faculties which were presumably given us to use. Such studies can only enhance our devout admiration and respect for the works of the Creator, yet from the earliest times we find that the devotees of religion and of philosophy, whether pagan or Christian, have looked askance upon the scientist and have challenged his conclusions. Plato in his "Republic" voices contempt for scientific studies in the remark: "If any one undertakes to learn anything of sensible objects, whether he gape upwards or bellow downwards, never at all shall I say that he learns, for I aver that he has no real knowledge of these things, nor shall I say that his soul looks upwards, but downwards, even though he learn lying on his back, either at land or at sea." Throughout the Christian era theological dogma has fought a losing fight against the development of science. To-day the force of this attack is almost spent, but there lingers still in many orthodox minds the hazy belief that the scientist is a materialist who ignores all spiritual values, who is oblivious to beauty in nature, poetry, and art, and whose labors are devoted to devising means for securing material wealth and selfish gratification. Those whose training has been confined to the humanities seem inclined to the view that there was once a golden age when all men were just and generous, enlightened and happy, when religion was pure and undefiled, and that science has destroyed this happy state. Man has eaten of the fruit of the tree of knowledge,

> The fruit of that forbidden tree whose mortal taste
> Brought death into the world and all our woe.

A recent writer in *The Atlantic Monthly* holds science largely responsible for the extirpation of culture, and claims that it has challenged the supereminence of religion, has turned philosophy out of doors, has thrown contempt on all learning not dependent on it, and has purchased support by the bribe of material comforts. Some have attributed the great war to the suppression of spiritual values by the influence of science, and

its horrors to malignant investigators who spend their lives in devising agencies of death and destruction. Usually this is suggested by innuendo rather than by specific allegations. As an example, consider the following statement of Stephen Coleridge in the *Saturday Review* for April 7, 1917: "Science never elevated conduct nor aggravated virtue; it never bade any one sacrifice his life for another nor to lead a forlorn hope; it never illumined charity nor condemned cruelty; its one positive perfected concrete human production in the modern world is the German." To the unthinking this rhetorical sophistry produces the effect of a convincing condemnation, whereas all that it really charges is that science has not done certain good things, without specifying any particular evils that it has wrought—except the German by-product. We must remember, however, that the Prussian is not a modern product—that morally he is to-day, in all international relations at least, what he was in the time of Frederick the Great, when there was little science in Prussia. Science has not made him what he is, but it is he who has perverted it to base uses. And what shall we say of the theologians, the clergymen, and the philosophers who have made the Hohenzollern ethics their own? Shall we therefore condemn all philosophy and religion?

Coleridge's statement would be quite as true if we should substitute for the word science the word art or food, neither of which is regarded as antagonistic to the better impulses of human nature. The statement would be quite as true—but how different the implications—if it were worded thus: "Science never degraded conduct nor diminished virtue; it never forbade any one to sacrifice his life for another nor to lead a forlorn hope; it never rebuked intelligent charity nor fostered cruelty." Further, it may be said with truth that science has never burned martyrs at the stake; it has never forbidden the use of the reason given by God to man, nor attempted to throttle human liberty; it has never bribed its disciples with power and wealth; it has never maintained that the end justifies the means nor claimed divine sanction for its evil deeds; it has done none of those things which have made religious dogma so feared and mistrusted that some highly civilized nations do not permit religious instruction in their public schools. We may see all around us the evidence that every implication of Coleridge's statement is untrue; that science does elevate conduct; that it does cultivate the spirit which causes men to lead forlorn hopes and to sacrifice their lives for others; that its whole influence is to foster the clean, the wholesome, and the good in our social

life; that it leads inevitably to the condemnation of cruelty and injustice; and the scientific study of history, with overwhelming evidence gathered from the experimental laboratory of human experience, gives the lie to the doctrine that any individual or state can with impunity violate the ethical laws upon which the safety and happiness of mankind depend. This doctrine has often been defended and put into practice by philosophers, theologians, statesmen and those who claim to rule by divine right. It would be impossible to find many scientists of repute throughout human history who inculcated or defended unethical conduct—with one recent exception, when a group of scientists surrendered their reason to a false philosophy of state and appended their names to a famous manifesto likewise signed by theologians, philosophers and lawyers. Many scientists, such as Galileo, have led forlorn hopes in defence of truth. In our own day and own country there have been men who have laid down their lives in the effort to discover through science the way to save their fellow men from suffering and disease; and science is seeking to salvage what it can of life, property and civilization from the holocaust which it had no hand in kindling.

I do not wish to cast opprobrium upon true religion, the religion of the Sermon on the Mount, which certainly gives no sanction to persecution or to the doctrine that might makes right. We must make every allowance for the spirit of the times, for ignorant religious zeal, for blind devotion to authority; but the fact remains that in all the celebrated cases, such as that of Galileo *vs.* Urban VIII., or those of Huxley *vs.* Gladstone and Huxley *vs.* Bishop Wilberforce, the balance not only of intellectual honesty, but of the Christian spirit of fairness, was overwhelmingly on the side of the scientists. I believe, moreover, that sober scientific judgment will ultimately convince mankind that the religion of the Sermon on the Mount, not that of the Hebrew God or of the Prussian God, is the necessary basis of an enduring civilization. This conviction certainly will never come from wrangling over creeds, rituals or articles of faith, nor by keeping such matters as Sunday observance and divorce in the ethical foreground.

It has sometimes been suggested—in fact, that was what Coleridge evidently intended to imply in the words quoted—that science is responsible in large measure for the great war and all its horrors. The claim that it contributed in any way to bring about the war is too fantastic to consider, for science has nothing to do with conquest, with commercial exploitation or with upholding the divine rights of dynasties. So far as the

horrors of war are concerned, it is quite true that many of the results of scientific investigation have been applied to the work of destruction, but they have been so applied, not by scientists themselves, but by those whose position and power rest upon the traditions and the superstitions which science has always challenged. We must remember, moreover, that the same principles have been used to combat the perverted uses which have been made of them. Nothing can be more unfair than to attribute to science the unworthy uses of it that have been made for selfish purposes.

It seems sufficiently evident that science is not antagonistic to righteousness, and there is abundant reason to believe that it has a positive ethical value—that it is, indeed, the greatest ethical force of our time. The end of scientific investigation is to discover the truth about all things, so far as man is able to grasp it—the truth concerning not only the material things and phenomena of the universe, but also the truth concerning man's instincts and impulses and all the relations of human society, and the truth concerning the consequences to mankind of the conduct of men and of states. Religion may and should inculcate righteous zeal, but this impulse alone, no matter how intense and sincere it may be, does not necessarily enable us to distinguish between right and wrong, and may even make us all the more zealous in wrong-doing. To make an ethical decision we must see all the relations of the subject to ourselves and our fellow men, and see them disinterestedly, without prejudice and without regard to authority and tradition. This is a mental attitude which is essentially scientific, and which is consistently developed by scientific studies alone. As an illustration, let me mention my own early experience. In the southern states slavery was regarded as having divine sanction. Any teacher or preacher who taught otherwise was ostracized or banished. For years after the civil war this tradition survived, and I was taught and believed that the abolitionists had thwarted the purposes of God. While still a boy various scientific books fell into my hands. Not one of them mentioned slavery or considered any ethical questions, but they quickly brought about a change in my mental attitude which caused me to see that slavery was wholly bad—a wrong to the enslaved and evil in all its effects upon the slave holders—not bad from any *a priori* consideration, but because human experience had proved it to be so. Blindly its defenders had taken their stand on the ground of moral principle, when a searching self-analysis would surely have convinced them that the only consideration

which determined their attitude was that of material self-interest; and a very short-sighted self-interest, overlooking the ultimate decadence of their civilization. John C. Calhoun, who received his early teaching from a Presbyterian minister, and who later received a classical and legal education, wrote: "We regard slavery as the most stable basis for free institutions in the world," and Judge Harper's legal training led him to the conclusion that "Nothing is more evident than that the institution of slavery is the cause of civilization." It would be impossible to imagine a man of scientific training making such palpably absurd statements as these. The fact is that no civilization tolerating slavery has ever endured; and that, in the words of John Stuart Mill, "slavery is incompatible with any high state of the arts of life and with any great efficiency of labor." Science did not flourish in the south—it is impossible to imagine that science and slavery could continue to coexist in the same community—but orthodox religions and classical scholarship have found nothing uncongenial in such association. It is well for us to ponder over such historical facts. There probably exist to-day among us evils as great as that of slavery. Our religious scruples are too easily overcome by self-interest; but science may open our eyes to the dangers that confront us.

Notwithstanding the lamentations of many that this is a degenerate age, when faced with the facts every one must admit that during the past thirty years there has been an immense improvement in the ethical standards of society. The political spellbinder has lost his grip; politics has in some measure been purified; official corruption has diminished; the standards of efficiency of our public officials have been raised; for the first time in our history the application of ethical principles to business affairs has made a little headway; we are beginning to question the perfection of our legal procedure; a new sense of civic responsibility and of our duty to our fellow men has been created, and we are acquiring new and higher ideals of patriotism and of international relations. This can hardly be the result of religious training, for this is generally acknowledged to have lost much of its efficacy; and furthermore, on the whole the influence of religious organizations has been conservative in all social and economic matters. They seem to consider that the antiquity of an institution or belief endows it with a vested ethical right to continued existence. It is probably more than a mere coincidence that the awakening from our moral stagnation began with the sudden increase of opportunities for edu-

cation in high schools and colleges and the general introduction of scientific studies into these institutions. None of the formal sciences undertakes the consideration of ethical questions, but the common aim of all the sciences is to discover the truth, regardless of tradition, authority, prejudice or personal interest. The habit of mind thus acquired can hardly fail to influence conduct in all social relations. I believe that Huxley's words are profoundly true: "It is becoming less and less possible for the man who puts his faith in scientific methods of ascertaining truth, and is accustomed to have that faith justified by daily experience, to be consciously false to his principles in any matter." To illustrate, scientists are rarely political partisans. Probably none could be found who would approve the giving of public office as a reward for political service, and this not because of any special virtue, but because their mental habits cause them to see clearly the evils of such a system. It is the rule rather than the exception that politicians of the highest Christian professions, or with predominantly classical and legal training, defend or tolerate this practise. No doubt prescribed courses in science would do much to purify the political atmosphere.

It would surely promote the administration of justice to give every lawyer a sound scientific training. Can any one doubt that scientific methods of obtaining evidence would be more effective than those followed by the courts? Would it not be better for society if the prosecuting attorney and the attorney for the defence should have the common aim of ascertaining the exact facts in each case, with a view to obtaining a just application of the law, rather than to have the former determined to convict, and admitting only those facts which will help to convict, while the latter is even more determined to make use of every possible technicality or perversion of the facts in order that his client may escape merited punishment? How strange and wholly unscientific the logic by which the opposing lawyers can from identical premises deduce precisely opposite conclusions!

Economics is called a science, but it would seem that it might employ scientific methods more extensively with profit. There is probably some ground for the suspicion that this generation is fettered with economic dogmas as past generations were fettered with religious dogmas. It seems to me that the accepted laws of economics are fundamentally unscientific in so far as they give only partial recognition to the feelings which determine human conduct and to the influence of the

conduct of individuals or of classes upon the general welfare of society. Political economy does not sufficiently take into account the qualities which differentiate men from the lower animals, and which should be recognized in any scientific study of the economic relations of men to each other—or rather, it makes a differentiation wholly in favor of the lower animals by assuming that man is dominated solely by a selfishness rarely found among brutes and a greed for material possessions which they wholly lack. As a result men of naturally good impulses are sometimes swayed from their better impulses under the compulsion of what they are told are inexorable laws of nature. To justify this impression, let me quote an early definition by John Stuart Mill:

> Political economy is concerned with man only as a being who desires to possess wealth. . . . It makes abstraction of every other human passion or motive. . . . It considers mankind as occupied solely in acquiring and consuming wealth.

Walker summarizes the attitude of the English school of economists in these words:

> The end of wealth man never fails to desire with a steady, uniform, constant passion. Of every other human passion or motive political economy makes entire abstraction. Love of country, love of honor, love of friends, love of learning, love of art, pity, shame, religion, charity, will never, so far as political economy cares to take into account, withstand the efforts of the economic man to amass wealth.

It would seem that the economic man is not a very desirable citizen. Mill later in his life rose to a higher level in his "Principles of Political Economy," which is a social philosophy giving some weight to the considerations which affect the highest welfare of society. There is probably a wide diversity of opinion among economists of the present day, but I am under the impression that teachers and leaders in business and law-making usually adhere to the principles set forth in Walker's summary. If these are indeed the principles which have governed the economic life of civilized countries, we need not wonder at the industrial and economic ills which seem to grow more acute as the years go by and the crowding of population makes the individual more and more dependent upon his fellows for opportunities of existence, development and happiness. Perhaps a more comprehensive scientific view—one which this war has already done much to advance—may some day give us a political economy which has for its end the welfare of society at large rather than that of the limited class of individuals who control the means of production and can at will increase their

wealth at the expense of the majority of mankind. This new political economy may convince us that the principle of *laissez faire* leads to anarchy, that the law of supply and demand may be controlled to man's uses as we control the law of gravitation, and that only those are worthy of liberty who are ready to make a free-will offering of it on the altar of social welfare.

In less enlightened times science was attacked because it contradicted what was regarded as divine revelation. The most orthodox will now admit that science was right in regard to these questions, but many still maintain that it is antagonistic to spirituality and beauty. If this is true, it must be because spirituality and beauty are attributes of supernaturalism, not of naturalism—because nature is ugly and sordid, so that only violations of natural law can make a legitimate appeal to man's nobler feelings. It is true that scientists study material things, but they are a part of the universe. Does God repent having made this universe? If so, why does he not destroy it as an unclean thing? If mind and soul are not degraded by their residence in the material body, why should it be considered degrading to study that body? Of late much scandal among the godly has been created by the speculations of some scientists as to the possibility that mental processes are direct consequences of physical and chemical changes. This is still an open question, but it is difficult to see why it has any more religious bearing than the Copernican theory, to which the churches have become reconciled. Behind these physical and chemical changes there is a first cause—call it God if you will—which no human mind can fathom or explain. It seems rather rash to assume that the powers of this God are so limited that he could not make a self-directing universe in which thoughts and emotions are determined by the interplay of atoms, as our bodily movements are directed by muscular contractions. Surely such a creator would deserve more admiration than would one who had bunglingly constructed a universe to which he must constantly lend a hand to keep it going. Although the scientist studies material things, there is perhaps no other class of men so unworldly, so little diverted from their life work by the temptations of wealth or power, idle pleasures or bodily comfort. No man is more impatient than he with narrow views concerning practicality or with the notion that the chief end of science is the invention of machines or industrial processes for man's material comfort and aggrandizement.

The boundaries of science will always be enlarged by specialists who will in many cases be so engrossed in their work

that they may be justly criticized for narrowness—but we often find specialists in art, literature and religion who are likewise deficient in Greek symmetry. Nevertheless, the scientists will always receive more censure, because his narrowness is not so like the narrowness of the average man as that of the workers in other fields, who are concerned with things more specifically human. But the good to humanity at large, which is our chief concern, comes not from the training of the specialist, but from the residual effects of various subjects upon the minds and conduct of those who study them. Certainly we must grant that the humane studies, which touch most closely upon man's intercourse with his fellows and with his esthetic enjoyments, are the indispensable basis of a sound education, but much of man's capacity for using his reason in the problems affecting his own life, including ethical problems, will surely be lost without some acquaintance, not so much with the facts of science, as with the method by which science attains demonstrated truth. Many of the opinions and institutions which society has inherited must be taken with a grain of salt. Science is the saving salt; but it does not follow, because a little salt is a good thing, that a diet exclusively of salt will be better.

In this discussion it has been necessary to refer to some of the limitations of formal religion, which claims the custodianship of ethics, and of the humane studies which make spirituality and beauty their aim, for the purpose of showing that science may be of help to both in realizing their ideals of the true, the beautiful, and the good. There has been no intention to decry genuine religion or to deny the fundamental importance of humane studies. The necessary basis of the most effective education must be the studies concerned with immediate human relations, the rules of conduct, the languages, the literatures, the arts, which spiritualize and beautify our lives and enable us to share them richly with others. But we can not exclude science with impunity, for if we do we shall surely lose much of the significance of the humane studies, and we shall fail to establish the highest criterions of conduct unless we see clearly the truths and understand the relationships which it directly or indirectly puts us into the attitude to perceive. The past has bequeathed to us a precious heritage of thought and of beauty, and among those long dead are many whose intellectual and spiritual authority will live for all time; but we have also inherited traditions which fetter our minds and souls, and institutions which weigh heavily upon us. Each generation must challenge the validity of the beliefs and institutions which

the past would impose upon it, and they must justify their claims to continued existence. The humane studies make us familiar with the treasures of the past, but they also sometimes render us unduly subservient to authority and tradition. Science inculcates the questioning and discriminating spirit; it respects no tradition that does not justify itself to reason, and listens to no authority which can not demonstrate its validity. It cultivates the open mind which is ready to accept new truths and the discriminating mind which presents their too hasty acceptance. Most people who have had some scientific training will quickly forget the details of the sciences they have studied, but the effect of the scientific method upon their minds will rarely be completely effaced. This method is simple and direct, and makes no use of the dialectic subtleties with which lawyers, theologians and philosophers have so often deluded themselves and their disciples.

Many great humanists have recognized the important part played by science in the ethical development of civilization. In "The Hope of the Great Community" Royce writes:

> Some motives which tend to render the genuine Pauline charity, the genuine love of the unity of the great community to which all civilized men may, when enlightened, consciously belong—such motives, I say, have been furthered by the arts, the industries, the sciences and the social developments of the nineteenth and twentieth centuries as thousands of years of previous activity have never furthered them. . . . How far reaching the abundant phases of human life are tending to become under the influence of those humane arts and sciences which of late have so successfully combated disease and brought together nations and men who once could not in the least feel their brotherhood.

Matthew Arnold was not over-partial to science, and rendered great service in criticizing the over-zealous claims of some of its adherents, but he clearly saw its place in liberal culture. He wrote:

> Hard unintelligence must be supplied and reduced by culture, by a growth in the variety, freshness, and sweetness of our spiritual life; and this end can only be reached by studying things that lie outside ourselves, and by studying them disinterestedly. Let us unite ourselves with our better mind and with the world through science.

Religion and philosophy, literature and art, history and science, each in due proportion plays its part in the intellectual and moral development by which alone we can understand and express the best that is ourselves and in the world. Each helps to show the path of wisdom, righteousness and fruitful living to him who seeks it, but none of them can help him who lacks the desire or the will to do right. Granted this inclina-

tion, I believe that the habit of mind which is developed by scientific studies is at least as important an ethical agency as the others, and I am inclined to think that in the present stage of civilization it is the most important. The scientist has the same human failings as other people; he may have no better intentions nor be no more righteous-minded than they; but he can sometimes act more intelligently in carrying out his good intentions. Science teaches us to seek the truth without prejudice; it develops the habit of disinterestedness; it leads us to consider all known elements in making ethical judgments; it prompts us to seek the amelioration of the health, the well-being, the happiness, of our fellow men; it diverts our vision from the fruitless contemplation of a past in which we can play no part to the present wherein lies our task; and it bids us to consider the future and the welfare of generations still unborn. The humanist seeks to perpetuate the wisdom and beauty of the past, and in doing this he renders no mean service; but he is apt to depreciate the present and to despair of the future, to forget that it is the task of each new generation to winnow the chaff from the gathered harvest and to plant the seed for new harvests. With the mutual sympathy and united efforts of humanism and science, civilization, firmly rooted in the past, may grow unhampered to its full fruition.

When this war is over it will be in a large measure the mission of science to rebuild a shattered civilization. It will restore the industries of nations; it will house the homeless, feed the hungry and cure the sick. But it will be even more potent in healing the deep-seated ills of society which are the consequences of past social misconduct, whether innocent or malicious. Good intentions and religious training, unaided by understanding, will not carry us far. Whatever good may come from prayer, intelligent men prefer to have their ailments treated by a physician who seeks the causes and cures of disease in a scientific manner, or the firm-handed surgeon whose knowledge of anatomy enables him to remove cancerous growths without killing the patient. It will be the task of men of scientific training or of scientific spirit to heal the wounds which have been wrought by the duplicities of statesmanship, by the selfishness of privileged classes, and by false philosophies and religions, and to remove malignant economic growths by radical operations. It is, I believe, the highest mission of science to contribute its part to the training of such men. The objective by-products of science, such as the telephone and the automobile, seem to me to be of relatively little importance; but

its subjective influence on man's intellect and conduct is of the highest consequence. In universal scientific training in this larger sense lies the hope of democracy.

Science has much to contribute to the happiness of the world in a material way, and it is right that it should be encouraged in this work. No doubt the lessons of the war will convince our government, our educational institutions, and our industrial organizations that too much can not be done to stimulate the material applications of science. But there is a real danger that too much stress may be laid on these material aspects of research, which are not science, but only its by-products. Competent investigators should not only be provided with facilities for their work, but they should be absolutely unhampered by any demand that their researches should be of immediate practical utility; and it is equally important for the interests of society that teachers of science should lay more emphasis upon its intellectual and ethical significance. Much of the ineffectiveness of scientific teaching in this country, its failure to inspire interest and to win respect, is undoubtedly due to laying too much stress on its practical, vocational, or narrowly scientific aspects, rather than on its humanistic side.

There is a materialism which in every age, especially during times of great prosperity, has insidiously weakened the mental and moral fiber of mankind—a materialism of wealth, of self-indulgence, of inordinate luxury. This materialism thrives on modern industrialism, but it has an economic rather than a scientific basis, although science is often held responsible for its defects, because scientific discoveries have had such a wide industrial application. The primary object of applied science is not to create wealth for individuals, but to lessen the hardships, cure the bodily ills, and increase the legitimate comfort and happiness of mankind at large. If this is materialism the good Samaritan was a materialist. An unscientific political economy has made it possible for individuals to prevent the general diffusion of these benefits, to acquire fortunes which have in no sense been really earned by bodily or mental effort, and to bring about a condition of industrial servitude which can only result in a social upheaval unless it is corrected. It would be well if religion, humanism and science, with a sympathetic mutual understanding, would join in a united and unceasing attack upon this materialism, which is their common enemy.

Wealth has its worthy uses, but selfish greed for riches and power blinds man's spiritual eyes and causes him to strive for

sordid and ignoble ends. Some scientists, in common with other human beings, have limited vision; but at the worst this vision is not directed to ignoble things and their aims are not selfish. They do not deny the existence or depreciate the value of the human attributes and aspirations which defy analysis in their laboratories. The aim of the scientist is to see clearly that which is, even though he cannot explain it; and he sees that the wages of sin is death for the individual or the state; that in mankind there is an instinct for the good, a reverence for self-sacrifice and moral heroism, for mercy and magnanimity, which is rarely completely suppressed in the worst of men; that men will die for immaterial ideals, and that the mysterious thing called beauty exercises a potent and wholesome influence over mankind. How these things came about and whither they tend he can not tell, but he knows that they are as real as the laws of mechanics, and that he, like other men, is swayed by them.

Intent upon his daily task, the individual scientist is hardly conscious that he has a creed, and could with difficulty define the forces which drive him. But there is a strong impelling force behind his activity. It is not a conscious ethical force, but neither is it a desire for wealth, popularity or power, nor for any wider recognition than that accorded by his fellow workers. This force is surely something more than idle curiosity; there is in it an element of devotion and of self-sacrifice, an impelling desire to contribute to the ultimate good of humanity in more than a material sense. Were he driven to make his aspirations articulate, he might formulate them in words not very different from those of St. Augustine:

> Let us not leave thee alone to make in the secret of thy knowledge, as thou didst before the creation of the firmament, the division of light from darkness; let the children of thy spirit, placed in their firmament, make their light shine upon the earth, mark the division of night and day, and announce the revolution of the times. The old order is passed, the new arises; the night is spent, the day is come forth; and thou shalt crown the year with thy blessing, when thou shalt send forth laborers into thy harvest sown by other hands than theirs, when thou shalt send forth new laborers to new seed times, whereof the harvest shalt be not yet.

THE PRINCIPLES OF EDUCATION

By Dr. P. G. NUTTING

EDUCATION covers the span of life from the cradle to the grave. Impressions are received in bits and blocks in an endless stream. Some of these pass almost at once into oblivion, leaving the merest trace in our minds. Other impressions, stimulating more or less interest through partial or anticipated connection with something already in our minds, are seized upon, inspected and then, if found true and worthy, tagged and pigeon-holed with other associated impressions. An occasional new impression of unusual strength will dominate a whole group of old impressions.

The mind then makes abstracts (ideas) of groups of impressions to connect with abstracts of other groups. The best measure of mentality is probably this tendency to interconnect and abstract the essential ideas in a wide variety of other ideas and groups of impressions. And mentality in this sense is a measure of the degree of education in an individual.

The impressions of an infant are limited to those received from its immediate surroundings. During school days, the mind receives and assimilates ideas from farther afield not associated with desire or discomfort. Later on, in high school and college days, the mind likes and readily assimilates groups of abstract related ideas and even probes the infinite and unknowable. In middle life, the dominant interest lies in the practical problems of everyday life. The field of our activities is our school and the newspaper and magazine our text-books. The mind demands fresh facts and new ideas. In later life, after the details of most minor problems have become familiar, interest turns once more to general principles and larger problems, details are reduced to routine when possible.

In short, education is as long and as broad as our lives. National welfare requires that it be recognized and treated as such. What we now call education is a mere generalization of parental instruction covering the period of most active interest in the most abstract ideas. Real education in the interest of the nation should be such as to develop and bring into action all the latent possibilities in every individual. Whatever our useful activities at any period of our lives, we should be continually receiving and assimilating new ideas with both bodies and minds fresh and active, with a code of ethics firmly established and a philosophy of life equal to any emergency.

In our present system of education, the responsibility of the nation to the individual is recognized for that part of the individual's mental education which he ordinarily receives from text-books. No attempt is made to instruct him or even to supervise his instruction in later life. He obtains by experience and the experience of others gleaned from chance conversation, from newspapers, magazines and from books such information and ideas as may better fit him or unfit him for his work and his share in the government. The value of knowledge gained in this manner is not to be decried, but it might be made much less casual than it is; the nation might at least see to it that false information and false doctrines are not disseminated and that no inquiring mind goes unsatisfied.

The *physical education* of its citizens has been left almost entirely to chance by nearly all nations, although physical strength and fitness are very important factors in the work of every one. The play and work of their daily lives, together with a casual indulgence in sports on the part of a few, make up the physical training of the masses. Considering its great value to the nation, it would appear advisable to encourage athletic sports, to provide numerous leaders for the specific purpose of encouraging athletic contests and getting all, even the modest, into the fields, golf links and tennis courts. The great value of universal military drill in strengthening the physique of the young adult is beyond question.

For the *moral education* of its citizens, the nation assumes no responsibility whatever. The code of ethics of the average individual is partly instinctive, but largely the product of home influence supplemented by that of one's associates. Various churches and Sunday schools essay the great task of looking after the morals of the public, but reach comparatively few in any vital manner. It must be admitted that their appeal to the public is not very general, partly on account of the nature of the material taught and partly on account of the methods used. The thought of possible punishment or reward in a future life are neither necessary nor sufficient to direct the activities of the average individual.

As a matter of fact, the strongest force influencing behavior is the instinctive desire to attain the respect and esteem of our associates. We know that in an hour we may, by improper conduct, lose the respect which required months or even years to build up and are careful accordingly. By hard experience we obtain knowledge of the safe limits of conduct and by generalization build up codes of morals, ethics and etiquette to gov-

ern our actions on future occasions much as a professional man builds up a knowledge of the fundamental principles used in his profession.

The individual who does his best and lives up to his best is sure of the respect of his associates, and since that respect is a criterion for correct behavior it is necessary and sufficient that we strive to attain and retain that respect. Having pleasure and attaining happiness and contentment are by some considered proper and sufficient objectives in behavior, but such motives and criteria are neither necessary nor sufficient in all cases.

Correct education in morals, ethics and manners consists in the formation of codes which, if followed, will lead to the continued and increasing respect of one's fellows. The great school of such education must ever be the complex activities of daily life. The lessons drawn from such activities, the fundamental principles involved, are the vital part of such education. What those lessons and deductions shall be is determined largely by the nature of previous mental reactions to somewhat similar conditions, hence results are strongly cumulative, correct or incorrect deductions are rapidly built into the structure and are difficult to modify later.

As stated, our codes of behavior are chiefly the result of our reactions to conditions of daily life. These are supplemented by lessons drawn from history, from fiction and at the present time, to a considerable extent, from motion-picture drama. Fiction and drama are nominally at least under state and national supervision. It is conceivable to even conservative minds that the nation might well exercise such control as would safeguard the general welfare or might even take steps to promulgate proper ideas and ideals. Possibly teachers of morals and ethics could be provided to conduct schools of morality and ethics for immature minds. The greatest teacher of morals of all times taught largely by parables and this method is second to none. In essence, it is instruction by the study of practical moral problems.

Tendencies in education at the present time are decidedly toward the objectives outlined above. High-school and college curricula are being pruned and modified to eliminate the less desirable in favor of the more useful studies. Those past school age and those whose duties do not permit school attendance are being reached by university extension courses and by correspondence schools. Certain colleges and universities are in favor with certain prospective students on account of the

superior opportunities offered in athletics, that is physical education as such is in demand. Technical schools are multiplying in numbers and improving in quality. Universal military training is being seriously considered. However, there has yet been no attempt at systematic general moral education nor any connected effort to instill the principles of industry or morality in our schools. Taking it for granted that such instruction is in the interest of the general welfare, fundamental principles should be worked out and taught by example and the study of practical problems.

The interrelations between mental, physical and moral education and general well being are well known, but rarely taken cognizance of and never made use of for definite ends. An active, healthy, well-trained body is no inconsiderable asset to the intellectual worker and an important factor in good morals. Athletic training and contests make for fair mindedness, patience and the faculty of concentrated effort. The height attained by Greek civilization is in no small measure attributed to the out-of-door life and fondness for athletic sports of the average Greek citizen. The value of sound morals and a sound philosophy of life on the general welfare of individuals and of a nation needs no argument. On the other hand, the value of the average college education to the average citizen is frankly questioned by many and not without reason. The defect in a poor academic education lies in its being a mere accumulation of knowledge; it fails to give that command of fundamental principles that comes only through research and the solution of numerous practical problems. Even the average college education, however, generally leads to a considerably enhanced ability and national tendency to "see straight and think straight," that is it tends to eliminate delusions of all kinds.

A good education results in increased *knowledge, training* and *activity;* along mental, physical and moral lines in its broadest aspect or in some limited field at its narrowest. Many of our great and useful citizens, by unstinted activity and through wide experience in practical problems, have made good in every sense of the word without any academic training. Mere breadth and depth of knowledge is of least avail, teachers and clerks generally are well supplied with it, but without first-hand knowledge of first principles and strong incentives to apply them, never make much progress. However, the gap between academic and industrial life, formerly so wide and deep, is now rapidly narrowing. In many industries college men are preferred as factory superintendents on account of

their clearer vision and lack of bias, while on the other hand our universities and scientific societies are coming into closer and closer touch with industry. Many of our best teachers of professional subjects are men who have become experts by practical work. With education at its best, every field of instruction in every institution of higher learning should be dominated by an expert having a thorough command of fundamental principles gained by research or practical work or both.

The Education of the Expert.—The interests of the public and of the nation will be served if all important problems, public as well as private, are in the hands of experts for solution. In administration, legislation, the public health service, agriculture, all branches of engineering, commerce and education, practical problems are continually arising and upon the correct solution of these problems depends the welfare of many individuals and even of the nation itself. The engineer applies fundamental principles to practical problems and to insure progress by the elimination of rule-of-thumb methods requires good engineering practise all along the line. In some fields present practise closely approaches all that it might be, in others almost barbaric incompetence is the rule. Our supply of possible experts is ample, our methods of training them produce good results, although open to much criticism, but our methods of getting the right men into the right places are woefully inadequate and costly.

The older economics recognized two chief factors in industrial welfare, labor and capital. It is now coming to be recognized that there are not two, but three, of these important factors—capital, the trained expert and labor. Without the expert neither capital nor labor can exist to-day for very long in any of the greater industries. He is neither a capitalist nor a mere laborer, but a solver of problems to clear away obstructions and open up new fields of activity. Industries to-day must progress or perish and advances can be made only by the application of organized administrators, engineers, chemists or other professional men. It behooves us therefore to use every effort to improve the quality and increase the number of our trained experts.

Statistics show that genius knows no caste. Men of great achievements originate in all classes in about equal percentages —they can not be bred. If eugenics plays a part, its influence is greatly overshadowed by other factors. Getting the right start and then giving full play to one's bent are the vital factors in developing capacity for great achievement. The right kind

of education helps all along the line, in the proper choice of life work, in the preparation for that work and in the development of special ability for advanced work. There are doubtless plenty of individuals capable of very much greater achievement had they but sufficient incentive to overcome their natural modesty, indolence or caution and the proper educational facilities for obtaining the knowledge required and technical skill in its use.

In early youth, before he begins to specialize, probably the best *mental* education for the future expert is not very different from that now generally received in this country, namely, an accumulation of abstract knowledge with training in the three R's. His *physical* education also is probably not subject to much improvement beyond a more universal indulgence in more out-of-door sports and games. But his moral, ethical and *psychical* education falls far short of what it might be. Between the ages of about ten and seventeen he reasons out what is worth striving for in life, forms his code of conduct, and sets up a scale of relative values in possible achievement. At this stage he is very sensitive to external influences, since such influences are strongly cumulative. And for the average youth such influences are of the most casual nature!

A tutor of Peter the Great is said to have formed and crystallized in his youth his purpose to raise Russia from semi-barbarism to civilization, and this he accomplished in the most energetic and single-minded manner in spite of his being deliberately surrounded with pleasures and temptations to wreck his career. It would appear advisable to tell to the young the stories of individuals of great achievement; of Peter of Russia, of Pasteur, of Joan of Arc, Columbus, Franklin and Lincoln, emphasizing the elements of their greatness; their mastering of first principles, their singleness and soundness of purpose, their readiness to attempt the difficult and well-nigh impossible, and their continual hammering away along their chosen lines of activity. In such lessons the moral, ethical and psychic are closely interwoven and the treatment should bring out all three. Nowhere in our schools do we have such teaching, but it is everywhere of vital importance to the general welfare in the education of the future expert. While we are discussing the teaching of the Bible in our public schools we overlook the opportunity of instruction in a field full of the greatest possibilities for national progress.

It is doubtful whether any selection or segregation of specially fit students is advisable before or during the high-school

period. No psychologist can select at sixteen just the individuals who will at forty be the most useful citizens in various fields of activity. Some mature early and achieve great results early in life, while others mature slowly and go further. Too early selection and specialization are likely to cost more than they are worth. Up to and through the high-school course the aim should be to give a broad and thorough grounding in the more important branches of academic training, together with a sound physique and a correct, efficient code of behavior.

Following the high school probably the best results are obtained by two years' work at a small college, followed by two years of partly specialized work at a good university with finally two to five years' work in a high-grade graduate or professional school. In all this work the first aim should be to secure a thorough grounding in the fundamental principles of the subject covered. Any profession first attains high standing when the fundamental principles upon which it is based are worked out and formulated. Any professional man can attain high standing in his profession only through a thorough knowledge of the fundamental principles of his profession and the ability to apply those principles.

In the interest of national welfare, mental qualifications alone should be the deciding factor in selection for advanced training. The best of college, university and technical education should be available to students in the humblest circumstances, with free tuition and opportunity for earning living expenses. It is the general impression that students who earn their own way are better represented in proportion among those of great achievement than those supported by their parents. Certainly no one should be excluded or subjected to a heavy handicap because of poverty.

The best of our graduate and technical schools, professional schools, industrial research laboratories and the government departments at Washington offer very nearly ideal training for the future expert in many fields of activity. There is a judicious combination of instruction and practical work under the supervision of capable experts to give the combination of knowledge and technical skill in solving problems required by the specialist. Those contemplating research as a profession should possess a thorough knowledge of the fundamentals in their chosen field, together with demonstrated skill in research. These are attained by well-directed study and research work. The lesser teaching positions in our universities offer excellent facilities for training the future expert; the teaching organizes

and hardens his command of fundamentals while graduate study and research advance his knowledge and skill in solving problems.

To provide more and better training for experts, we need (1) more high-grade technical and professional schools, (2) closer relations between the pure research of our universities and industrial research, (3) a broadening of the curricula of our graduate and technical schools to cover fields (such as city administration, illuminating engineering, glass technology, etc.) at present neglected and (4) a central national university of the highest grade to centralize and lead activity in the various fields of professional education and research. It is a hopeful sign that present tendencies are toward all these research ends.

Present methods of training the future expert are open to considerable criticism. The story is told of one of our leading experts in the geology and metallurgy of gold that when the ambition to become such first stirred him he went to Agassiz for instruction. Agassiz gave him a turtle and told him to study it. After several weeks of patient effort he took his results to Agassiz with the statement that he knew all that was to be found out about that turtle and was ready to start the study of gold. He was, however, sent back again and again to his turtle until he knew every detail of its markings, its habits, its appetite, its rate of growth and every movement. Finally, after months of work on the turtle, he was told to go and study gold. The critical period in his career of achievement was that during which he learned how to observe and study. Our higher education is not sufficiently intensive. It is too hurried and lacks definiteness of purpose. Fundamental principles are not emphasized by the teacher nor mastered by the student. Side issues are allowed to divert the attention and break the chain of concentrated effort to completely solve definite problems. These defects are due partly to a national trait of mind, but the proper influence from leaders would do much to correct it.

Although national welfare demands that education should be provided for all and the aim of every individual may properly be that of becoming an expert in some one line of activity, it is by no means to be expected that the yield of specialists will be 100 per cent. There will always be a percentage of partial defectives of all degrees of efficiency. These will always supply the unskilled and the less skilled labor for the rule-of-thumb trades. If universal military service were adopted, not all would be found physically capable of full training, but only cripples would be unfit for some sort of physical training and

service. In any case equal opportunities should be provided for all and actual fitness should be the sole deciding factor in determining whether education of any given grade is to be provided for any individual.

Education in middle and later life is chiefly through two channels: increased technical skill through practical work, increased knowledge of fundamental principles through the technical journals. Education in its broader aspect, fitting the individual for his broader duties as a citizen, comes through similar channels, daily intercourse with one's fellows and through reading the newspapers and magazines. It is probably because the human mind has for ages been developed by this dual form of education that similar methods give best results during the student period.

The proper kinds of magazines, scientific journals and newspapers are powerful tools for educating the general public in their various fields of activity. Instead of the present laissez-faire policy of our government, ignoring the fact that such channels of information are powerful factors in general education, it would seem to be in line with general welfare to exercise some supervision over their conduct. Newspaper charlatanism, in which the interest of the individual or of a party has been placed above that of the nation, has worked untold mischief in this country. Inane editorials are the rule rather than the exception. It would doubtless be in the interest of national welfare if editorials were written only by those familiar with the basic principles of national welfare. The nation could well spare all papers run in the interest of individuals, of political machines or any organization that puts its own interests, even in times of peace, above those of the nation.

In the conduct of our scientific and technical journals there is much room for improvement. The best of these are models of their kind, others are run in the interest of the society whose organ they are, regardless of future value as works of reference. At least one journal prints articles in fields as diverse as archaeology, pure mathematics and physiological chemistry. No one reader is interested in perhaps more than a fifth of the matter printed, yet the whole is bound together. There is a great deal of overlapping in some fields while other fields are without any good reference journal. In practically all cases, the individual members of scientific societies are under heavy burdens of expense to maintain their journals. It would seem advisable to see that all fields of science and technology were properly cared for in the interest of general welfare, to the extent of regulation and subsidy if necessary.

MINERALS AND POWER

By Professor F. E. WILLIAMS
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THE importance of minerals in warfare is attracting the consideration of nations as never before. In time of peace the value of a nation's mineral deposits is easily underestimated. The higher the stage of development, the more essential become its mineral supplies. We have used the terms stone age, copper age, bronze age, iron age and coal age to designate different periods in the evolution of progress. Now, not only are we using far more coal per capita than ever before, but also vastly greater quantities of the materials that characterized former periods, namely, iron, copper and stone.

The development of the United States in industries, other than agriculture, is illustrated in the increased use of its mineral resources. Agricultural exports have increased greatly, but not in proportion to the mineral exports and the manufactured articles which have resulted from their utilization. In the period since 1880, foodstuffs (though showing an actual increase) have fallen from 55 per cent. to 21 per cent. of the total exports, while the export of manufactures has increased from 24 per cent. to 58 per cent. Exports of mineral products and manufactures thereof have increased from less than 4 per cent. in 1880, to 42 per cent. of the total exports in 1913 (the latest year unaffected by war conditions), an increase in value of more than one and one half billion dollars.

It is even more surprising if we compare the output per capita of the more important minerals for the last one third of a century. While the population has but doubled, the production and consumption of coal per capita has increased from less than 1½ tons to nearly 6 tons—an increase of 357 per cent. The United States took first rank in the production of coal in 1899 when Great Britain was surpassed and this lead has been maintained ever since. The production of iron ore increased 337 per cent.; petroleum 391 per cent.; copper 1,200 per cent.; cement 2,087 per cent.; gold, 23 per cent.; silver, 22 per cent.; lead, 125 per cent., and zinc 638 per cent. At the same time, the increase in agricultural products has but little more than kept pace with the growth of population, with the exception of cotton and sugar, which show advances of 130 per cent. and 394

per cent., respectively. Especially has the south increased its mineral production. In 1882 the Southern States produced but 8 per cent. of the mineral output of the United States; in 1890, 14 per cent.; in 1900, 16 per cent.; in 1910, 19 per cent.; and in 1914, 22 per cent.

The future of the mineral industry is assured, because of the increasing diversity of products and the known reserves of many minerals. In 1880 the statistics of mineral production in the United States covered about fifty articles, while the accompanying table shows over 75 items of considerable importance, and the report of the United States Geological Survey (1915) mentions about 90 additional products. Before 1880 the base metals and nonmetals were of subordinate importance, but now the former have come to the front and the latter have exceeded the total value of all the metals. The accompanying table shows that gold and silver have increased but a comparatively small percentage. Part of the output of these two metals, especially the silver, is from the by-products of copper and lead mines. Sulphuric acid, another by-product, has been in the past an embarrassment to operators of smelters, but is now a commodity of great price. Much of the platinum produced in this country is won from the refining of gold bullion and copper matte.

During this period of marked growth in mineral production, there has been a change in the character of the deposits worked —a passing from the exploitation of bonanzas to the working of low-grade deposits. This has led to the establishment of larger and more permanent communities and hence to a safer foundation for progress.

The relation of mining to other industries is obvious, and, for the last few decades, especially in western and northwestern America, the miner has been the pioneer of civilization. Since there has been such an enormous production from lean ores it follows that estimates of our reserves are constantly being raised. This increase in estimated reserves has also been brought about by further exploration. A few years ago it was estimated that the visible reserves of copper ore for four districts in three states was about 160,000,000 tons. Now these four districts are known to have 600,000,000 tons of reserve in spite of the fact that 60 million tons have already been mined. In like manner there has been an added estimate of phosphate rock and coal reserves. The field work done by the United States Geological Survey has increased the estimates of reserves of phosphate rock from a few hundred million tons to more than

five billion tons. The quantity of easily accessible anthracite and bituminous coal exceeds the estimated tonnage in 1909 by 440 billion tons, an increase of nearly 30 per cent., and the day of opportunity for both exploration and investigation of the mineral resources of this country is not by any means past.

The accompanying table shows the enormous growth of mineral production in the United States in the last thirty-seven years. Some of the statistics are a little misleading, as is always the case where values are given instead of amounts. Prices change from time to time and often enormously. Amounts for the earlier years are hard to obtain, and it was thought best to keep the values as a basis for comparison throughout. It can be seen that most of the outputs have increased much more rapidly relatively than the population. In some cases there has been a steady growth in the utilization of some particular product; in others there are sudden rises due to new discoveries or inventions or to abnormal conditions in trade or manufacture, for example, the exigencies brought about by the present war. The effect of the war is easily seen if we consider our exports since 1914. The exports of the articles considered in the accompanying table show an increase of about 300 per cent., or from $515,000,000 in 1914 to $2,043,000,000, in 1917. The value of the exports of coal and coke rose from $62,700,000 in 1914 to $89,400,000 in 1917; copper and copper manufactures from $149,400,000 to $323,900,000; iron and steel, including manufactures but excluding machinery, from $135,800,000 to $867,100,000; lead and lead manufactures, from $3,100,000 to $16,500,000; zinc and zinc manufactures, from $1,000,000 to $67,100,000; brass and brass manufactures, from $7,400,000 to $383,200,000; cartridges from $3,500,000 to $65,100,000, and petroleum, from $152,100,000 to $230,900,000.

With the anomalous conditions brought about by the war there has been a great development of many of the rare minerals. Many others, formerly of but little industrial value, have been used for substitutes for those which are practically indispensable. Whenever other factors do not interfere the industries of any nation are generally more stable when it contains within its borders the basic raw materials for the maintainance of its industries, but with the great diversity of modern manufactures many nations demand a variety of substances all of which are rarely available on one continent. The cheap water transportation between continents permits the competition of foreign and domestic resources. This is especially true if there is no tariff. The tendency has been, therefore, for the

richest deposits to supply the markets of the world. This condition has been changed by the location of many resources with respect to warring countries and by the great scarcity of ships, hence, the development of the substitutes and rare minerals of the United States.

Titanium, which had declined in use because of the open-hearth method of making steel, having supplanted the Bessemer process, is again in demand as a substitute for manganese in some processes, and also for aluminum in deoxidizing steel.

Much manganese dioxide was used before the war in neutralizing the greenish color of untreated glass. Much of this had come from the Turkish empire, and the available ore from other sources furnished the material at too high a price. It was found that selenium, which had been but little more than a curiosity, could be substituted. As a result there were about 50,000 to 60,000 pounds of selenium used in 1917. Selenium is a by-product of copper refining, and made only in the United States. Its success in connection with glass seems to assure its permanent use in the future.

Uranium and vanadium have also been used much more extensively since the war began; the former in ferro-alloys in connection with tungsten to reduce the quantity of the tungsten and the latter in ferro-alloys which have great shock-resisting qualities, as for heavy frameworks for locomotives.

Molybdenum is in great demand, having doubled in the world's production in the last two years. It has many important uses where resiliency and shock-resisting steel is needed. One of the important uses at present is in the lining of cannon and gun barrels which greatly lengthens the usefulness of each.

Cadmium is a mineral whose output was hardly worthy of mention in 1913; in 1916 there were produced 135,212 pounds, valued at $205,433. Before the war the chief output came from Silesia and hence was shut off from world trade. Some has been recovered in various processes in which zinc compounds are involved. It is used as a pigment and at present is important in some secret war use.

Chromium gives hardness to an alloy and prevents rust, consequently there has been a great demand for chrome steel for war purposes. Hence a great increase in production of cromic iron ore has been brought about since 1914. Another important use of chromium is in the tanning of chrome leather. In 1913 the United States produced 255 long tons, valued at $2,854; in 1916, 47,035 long tons valued at $726,243; and in 1917 there was a slight increase over the latter figure. The prin-

cipal sources of production were Rhodesia and New Caledonia, with lesser amounts from Russia and India.

Prior to the war, from 90 per cent. to 95 per cent. of the world's platinum came from Russia. The only other important source was Colombia. The normal world's production is about 250,000 troy ounces. In 1913 the United States produced 1,034 troy ounces of platinum (and allied metals), valued at $46,530; in 1916, 28,088 troy ounces, valued at $2,301.762. It is used in jewelry, chemistry, dentistry and electrical contact points. Paladium may be substituted for platinum in dentistry where great strength is not needed. At present there is a strong demand for platinum for use in the manufacture of sulphuric acid.

Because of the enhanced price quicksilver has increased in production very rapidly in the last few years. The chief producers are Spain, Italy, Austria-Hungary and the United States. In 1913 the United States produced 20,213 flasks (75 pounds net), valued at $813,171; in 1916, 29,932 flasks, valued at $2,576,547; in 1917, 36,351 flasks, valued at $3.857,000. It is used mainly in the manufacture of fulminate for explosive caps, of drugs, of paint, of electrical appliances, and scientific apparatus, and in the recovery of precious metals by amalgamation. The first use mentioned above caused the great demand and high price, with consequent increased production.

Ten years ago, tungsten was only of moderate use in the steel industry. Now the world's production is about 10,000 tons and the United States is the largest producer of tungsten ore in the world. Before the war, Germany controlled the output from ore supplies, largely from British possessions, but it is manifestly the intention of England to control most of the minerals of the Empire in the future. Tungsten is the most important of the metals used in high-speed steel. About 90 per cent. of the tungsten output is used in alloys, mostly in steel.

In the case of manganese ore which has become so necessary to modern industries and which for a period of years was supplied by many deposits in several countries, there has been a steady decline in the production from minor deposits relatively near markets and a corresponding increase in production from a few rich, even though remote, deposits. None of the industrially important nations produce more than a very small part of the manganese ore that they need; all of them have procured most of this in normal times from the three important sources in the world—Russia, India and Brazil. Manganese and manganiferous ores (the two chief sources of manganese) were produced in the United States in 1913 to the amount of 4,048 and

NON-METALS

	1880	1900	1913	1916	1917
Arsenious oxide	.....	.....	159,000	555,000	1,300,000
Asbestos	4,312	16,000	11,000	448,000	
Asphalt	4,400	416,000	5,282,000	7,102,000	
Barytes (crude)	80,000	188,000	156,000	1,011,000	
Borax (crude)	277,000	1,018,000	1,492,000	2,409,000	
Bromine	115,000	141,000	115,000	922,000	
Calcium chloride	.....	.....	130,000	217,000	
Cement	1,853,000	13,284,000	89,551,000	104,689,000	Slight increase
Clay	200,000 (potter's)				
Products	.....	96,212,000	181,289,000	207,260,000	
Raw	.....	1,840,000	4,180,000	5,752,000	
Coal					
Bituminous	53,444,000	220,930,000	565,235,000	665,116,000	Increase, 8.3 per cent.
Pennsylvania anthracite	42,197,000	85,758,000	195,181,000	202,010,000	Increase, about 20 per cent.
Cobalt oxide	24,000	12,000	.....	.....	
Coke	6,631,000	47,443,000	128,922,000	170,841,000	
Diatomaceous or infusorial earth and tripoli	45,600	24,000	286,000	242,000	
Emery	29,000	103,000	4,800	124,000	
Feldspar	60,000	181,000	777,000	702,000	
Fluorspar	16,000	95,000	736,000	923,000	
Fuller's earth	.....	68,000	370,000	707,000	
Garnet (abrasive purposes)	.....	123,000	183,000	209,000	
Gems and precious stones	100,000	233,000	319,000	218,000	
Graphite	50,000	.....	.....		
Amorphous	.....	198,000	39,000	21,000	
Crystalline	.....		254,000	915,000	Increase, 24 per cent.
Grindstone and pulp stone	500,000	710,000	856,000	766,000	
Gypsum	400,000	1,627,000	6,775,000	7,959,000	
Lime	19,000,000	6,797,000	14,648,000	18,619,000	Decrease, 10 per cent.
Magnesite (crude)	.....	19,000	77,000	1,394,000	Increase, 100 per cent.
Marls	500,000	30,000	.....	.....	
Mica					
Scrap	.....	55,000	83,000	70,000	
Sheet	128,000	93,000	354,000	524,000	
Millstones	200,000	33,000	56,000	45,000	
Mineral paint					
Natural pigments	146,000	644,000	512,000	Value given under unspecified	
Zinc and lead pigments	764,000	3,667,000	9,021,000	23,516,000	24,614,000
Mineral waters	500,000	6,245,000	5,631,000	5,735,000	
Natural gas	.....	23,699,000	87,847,000	120,227,000	
Oilstones	8,000	174,000	207,000	155,000	
Peat	.....	.....	197,000	369,000	
Petroleum	24,601,000	75,989,000	237,121,000	330,900,000	Increase, 14 per cent.
Phosphate rock	1,124,000	5,359,000	11,796,000	5,897,000	
Potash	.....	.....	.....	4,243,000	
Pumice	.....	.....	55,000	82,000	
Pyrite	5,000	750,000	1,286,000	1,966,000	
Salt	4,830,000	6,945,000	10,123,000	13,646,000	Increase, 9 per cent.

NON-METALS

	1880	1900	1913	1916	1917
Sand					
Glass	.....	.....	1,896,000	1,958,000	
Molding, building and gravel	.....	.....	22,322,000	27,852,000	
Sand, lime brick	.....	.....	1,238,000	1,474,000	
Silica (quartz)	80,000	127,000	201,000	243,000	
Slate	1,530,000	4,240,000	6,175,000	5,339,000	
Stone	20,626,000	36,971,000	83,733,000	79,042,000	
Sulphur	21,000	88,000	5,480,000	Under unspecified	
Sulphuric acid	.....	.....	4,346,000	14,100,000	Increase, over 50 per cent.
Talc and soap stone	67,000	384,000	1,120,000	1,292,000	
Talc (fibrous)	55,000	500,000	789,000	962,000	
Thorium minerals (monazite)	.....	49,000	.....	3,400	
Zircon	.....	49,000	.....	.....	
Unspecified	6,000,000	1,000,000	420,000	15,000,000	

Figures for the year 1917 must be regarded as approximate, rather than final. "Increase" or "decrease" applies to amount, not values.

METALS

	1880	1900	1913	1916	1917
Aluminum (consumption)	.....	$1,920,000	$13,845,000	$33,900,000	
Antimonial lead	240,000	995,000	1,592,000	4,464,000	
Antimony	10,000	838,000	429,000	Figures not available	
Bauxite	.....	90,000	998,000	2,296,000	
Cadmium	.....	.....	.....	205,000	
Chromic iron ore	28,000	1,400	2,854	726,000	Slight increase
Copper (value at New York city)	12,943,000	100,615,000	189,795,000	474,288,000	510,000,000
Ferro-alloys	.....	.....	13,015,000	50,282,000	
Gold	36,000,000	79,171,000	88,884,000	92,590,000	84,457,000
Iron ore	23,157,000	66,590,000	130,906,000	181,902,000	236,178,000
Pig iron	89,316,000	259,944,000	458,342,000	663,478,000	Slight decrease
Lead (refined value at New York city)	9,573,000	22,961,000	36,245,000	76,207,000	78,816,000
Manganese ore	86,000	100,000	40,000	627,000	Increase 300%
Manganiferous ore	Included under iron ore		25,000	2,005,000	
Nickel (value at New York city)	257,000	3,886	79,000	671,000	Decrease, about 20 %
Platinum	400	2,500	47,000	2,302,000	
Quicksilver (value at San Francisco)	1,858,000	1,273,000	813,000	2,577,000	3,857,000
Silver	34,717,000	35,741,000	40,348,000	48,953,000	About same
Tin (metallic equivalent)	.....	.....	47,000	no figures	
Titanium ore (rutile)	400	1,300	49,000	no figures	
Tungsten ore (60 per cent. concentrate)	.....	11,000	672,000	.....	Increase 800T (16%)
Uranium and vanadium minerals	.....	.....	609,000	no figures	
Zinc, sales values	2,833,000	10,902,000	37,772,000	151,005,000	102,350,000

59,403 long tons, respectively, and valued at $40,080 and $25,124; in 1916, 26,997 and 548,803 long tons, valued at $627,417 and $2,005,491. In 1917 there was an increase over the 1916 production of manganese ore of about 300 per cent. The use of ferromanganese and spiegeleisen in manganese steel is a well established industry. Manganese is used to remove oxygen and sulphur from steel and thus render it very hard, but still ductile, therefore, such steel is used for a number of purposes requiring a hard, tough steel. Manganese ore is also used in dry batteries and in the flint-glass industry.

Magnesite has increased in production many fold. It is used for refractory bricks in open-hearth furnaces, composition flooring, fire-resistant paint, sulphite process in wood pulp manufacture, heat insulators or covering for steam pipes, and in magnesia cement. Magnesia cement is used for making decks of ships, floors of hospitals and railroad cars, and has been employed successfully in the European war for making gun emplacements, as it sets quickly and has some resilience.

There are many other substances that have increased abnormally in the last three years. Of these may be named, asbestos, barytes, potash, sulphur, iron pyrite and sulphuric acid.

In a report to the President a few years ago, the Secretary of the Interior, in speaking of the resources of the country, gave minerals a high rank and referred to them as "The Foundations of Power." "A nation that produces under normal conditions 40 per cent. of the world's coal and 66 per cent. of its petroleum surely has its share of the two great fuels; add the fact that our mines, furnaces and smelters yield 40 per cent. of the world's iron, 60 per cent. of its copper, and 32 per cent. of its lead and zinc, and the reason is patent for America's industrial greatness."[1]

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MEDICAL LABORATORIES

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THE utilization of laboratory methods in the diagnosis of infectious diseases probably dates back to the time when the *Bacillus anthracis* was found to be the microbe causing anthrax in sheep and when Pasteur discovered the organism producing "pebrine" in the silkworm. In 1880, the protozoan causing malarial fever was identified in the blood and thereafter in rapid succession the bacteria inducing many other diseases were described. Methods for the isolation and study of the various disease-producing germs were developed to such an extent that the new science of bacteriology became established and subsequently expanded so greatly that few bacteriologists claim expert knowledge in the entire subject. As a result of the study of the action of pathogenic bacteria on the animal body, it was found that many organisms induce the formation of specific substances, the presence of which may be readily found in the blood. Two common illustrations of this phenomenon are typhoid fever and syphilis.

In all departments of science, what are primarily toys or curiosities soon become useful and necessary appliances in everyday life. This constitutes progress. The science of medicine in particular leaps forward with each new discovery or new method of procedure. Witness the germ theory of disease and its subsequent elaboration and proof; the far-reaching effects of the observation by Theobald Smith and Kilbourne that insects may act as the intermediate hosts in the transmission of disease; the value of prophylaxis, the perfection of the microscope, the invention of the stethoscope and the use of the aniline dyes in bacteriology and pathology. The story of the marvelous progress of medical science during the past fifty years is more interesting than anything hitherto published and yet the tale is but begun. The narration of medical progress is of extreme interest to the lay public and this is testified to by the avidity with which magazines and newspapers publish medical news in all detail. This interest should be encouraged and stimulated, for only with the active cooperation of the public can medicine accomplish its greatest triumph—the elimination of disease by preventive measures.

The hot-house of medical progress is the laboratory. Destroy the laboratory and we revert to the medical practice of the fifteenth century. The physician would again take up his individual method of guessing in which he is frequently justified by a kind nature which has limited the progress of most diseases. In the absence of animal experimentation the old "shotgun" prescription would again come into vogue, and the unscientific and irrational use of a multitude of drugs would be the prevailing fashion. Since laboratory methods are often precise in the information which they yield and in many other instances give highly suggestive findings, it is logical to conclude that they should not be neglected even in apparently trivial cases. Experience may be extensive, knowledge deep and the special senses highly developed, but instruments and exact methods should be employed for confirmation if not for purposes of actual diagnosis. Information thus obtained is a source of great satisfaction because a permanent record is established, and the subsequent treatment justified.

Diagnosis of the disease present is essential because upon it depends not only the character of the treatment, but also the prognosis which frequently is of great importance and invariably most earnestly inquired about by the patient. While he may feel interested in knowing the name of his affliction, the sick person is more concerned regarding the ultimate outcome of his case. The value of prognosis is well illustrated by typhoid fever. This disease is caused by the *Bacillus typhosis* and the diagnosis may be established by finding the microbes in the blood during the first three or four days of the illness, or by subsequent examination of the blood by the Widal method and by counting the leucocytes. Typhoid fever is a "self-limited" disease and the mortality is usually 5–20 per cent., varying somewhat in different epidemics. Closely related to the typhoid bacillus is the paratyphoid bacillus, of which there are two strains. Infection by these organisms produces a train of symptoms similar to typhoid fever but more mild. Fatal cases are extremely rare and in paratyphoid fever the physician would have no hesitancy in predicting a favorable termination of the illness. The diagnosis between these conditions can only be established by laboratory methods.

In medical practise the physician finds many diseases the manifestations of which are so typical as to leave no doubt regarding the diagnosis. Thus scarlet fever, measles and smallpox are detected without great difficulty. There are many others, however, with variable signs and symptoms in different

individuals and it is in these cases that the laboratory plays so important a part. As a matter of interest, let us group the various diseases commonly found in this country according to their dependency for diagnosis on laboratory methods.

GROUP A

Diseases diagnosticated with certainty by laboratory methods

Typhoid fever	Leprosy
Syphilis	Tetanus
Diphtheria	Gaseous gangrene
Cholera	Diabetes
Cerebrospinal meningitis	Malaria
Gonorrhea	Intestinal parasites
Tuberculosis	Trichinosis
Actinomycosis	Anemia
Bacillary dysentery	Pernicious anemia
Amebic dysentery	Leukemia
Anthrax	Chlorosis
Pneumonia	Hemophilia
Glanders	Tumors

GROUP B

Diseases in which the diagnosis is greatly assisted by laboratory methods

Septicemia	Abscess
Nephritis	Appendicitis
Gout	Peritonitis
Lead poisoning	Asthma
Poliomyelitis	Erysipelas
Typhus fever	Influenza
Vincent's angina	Whooping-cough
Pneumonia	Smallpox
Meningitis	Tumors

The above list, although not very long, includes by far the greatest amount of morbidity ordinarily prevalent. Most diseases are due directly or indirectly to bacteria and the demonstration of the presence of the suspected pathogenic organisms usually suffices to establish the diagnosis. The exceptions are the few instances in which individuals normally harbor disease-producing bacteria. Such persons are termed "carriers" and the most frequent examples are those that harbor diphtheria bacilli in the throat or typhoid bacilli in the intestine or gall-bladder. In the army cantonments it has been shown conclusively that normal individuals act as carriers of virulent meningococci and pneumococci.

In recent years laboratory work has received great emphasis in medical education. Medical colleges are usually judged and

rated by the quality of their laboratory courses and consequently the young graduate of the present day considers, and rightfully so, that laboratory methods are essential to the successful practise of medicine. He regards the necessary apparatus as part of his armamentarium and, indeed, as important as the stethoscope or thermometer. Laboratory technique, however, is so time consuming that busy practitioners find it impossible to perform any but the simplest examinations and so turn to the nearest well-organized institution for assistance. While recent graduates maintain a proper viewpoint toward the diagnostic laboratory, the older practitioners are too often indifferent and unwilling in many instances to avail themselves of laboratory service. They are content with their clinical diagnosis and, while undoubtedly correct in most instances, yet they should confirm their estimate of the case by an exact method if available. In this way only can they successfully claim to be scientific practitioners of medicine.

When we speak of exact methods in diagnosis we usually mean an accuracy of 90–95 per cent. Because of the multitude of variable factors concerned and the changing conditions of the body, it is scarcely possible to attain greater accuracy. Usually in practice the chief reason for the failure to arrive at a correct diagnosis lies in the lack of thoroughness on the part of the physician or the omission of repeated tests and examinations. When one considers the complex human organism and the frequent variations in the course of disease it is scarcely to be expected that a given set of factors necessary to the diagnosis will remain constant through any great period of time. Thus by way of illustration is leukemia a progressively fatal disease in which, however, "remissions" occur, that is, periods, usually of brief duration, when the patient is practically normal so far as can be determined objectively. Of course, an examination made at such a time will yield negative results and yet a few days later decided and positive changes will occur. Again, in malaria, the blood when examined between chills may be negative, but shortly before the chill will be found to contain myriads of the specific organisms. In diabetes, no sugar or very little, may be found in the urine, but the blood, on examination, will be found to contain a greatly increased amount. Thus it will be seen that the intelligent application of laboratory methods is essential to success. Properly speaking, the medical laboratory should not and can not as a rule make a diagnosis. The laboratory worker reports his findings to the physician, who correlates the results with his clinical observations and

thus arrives at the true diagnosis. Medical laboratories are frequently termed diagnostic laboratories, but improperly so, for their function is to obtain additional data for the attending physician who is the only one qualified to make the diagnosis. Laboratories may occasionally be in error in their reports, either because of the natural fluctuations or complications of disease or because of incomplete observations, or more rarely error in technique. That "experience is fallacious and judgment difficult" is just as true to-day as in the time of Hippocrates, but the degree of error in diagnosis is constantly decreasing. The personal equation, however, is still an important factor in the work.

In every community where hospitals are situated, many surgical operations are performed during the year and tissues or organs removed from the body, but not always submitted to the pathologist for examination. All such specimens should be sent to the laboratory for microscopic study. Complete records, including stained sections of the tissue, should be made and kept permanently. Thus in later years, if necessary, it will be possible to examine these records in the light of new illnesses or symptoms that may arise. This is more frequently necessary than is commonly believed, particularly in the case of abdominal operations, where the removal of an appendix or ovary, for instance, is in question. Our best surgeons have such examinations made as a routine for several reasons, chiefly, however, as a matter of scientific interest and to confirm their pre-operative diagnosis.

That many physicians who are indifferent to the advantages offered by laboratory assistance can no longer remain so is becoming more evident with each succeeding year. The public is gradually acquiring a rather extensive knowledge of disease and the application of laboratory methods, and many patients now show a decided interest in the laboratory reports. This attitude should be encouraged because it will lead to greater cooperation on the part of the patient in treatment and preventive measures. During the present Great War the sanitary department of the army has acquired a position second to none in importance and the chief reliance of that organization is upon the laboratory. The increasing activity of state and municipal health departments who insist on laboratory examinations in suspected cases of tuberculosis, typhoid fever, poliomyelitis and meningitis is but one indication of the importance of the medical laboratory. The war has brought about a serious and earnest attempt to control venereal diseases. Registration of

infected individuals will undoubtedly soon be required in many states and the basis for the acts of the authorities will depend largely, if not entirely, on the laboratory examinations. When this war is over, millions of men will return to civil life impressed with the value of the laboratory in the diagnosis and prevention of disease. They will know that typhoid fever, pneumonia, meningitis and many other diseases are only properly diagnosed by the finding of the causative organism, that the rational treatment of wounds and other infections depends upon knowing the nature of the bacteria present, that the efficacy of the treatment for syphilis can be best judged by the Wassermann reaction and that the diagnosis of a host of other conditions requires special skill and training on the part of the physician. The doctor can no longer arbitrarily say to his patient that he has such or such ailment, but must in support of his diagnosis cite the laboratory report. This information not only helps the patient, but is also instructive to the physician.

Diagnosis, however, is only part of the work of the medical laboratory. No such institution is properly organized unless ample funds and facilities are available for research. While the efficiency of the laboratory may be kept at a high point in the performance of routine tests, the systematic investigation of new problems should be part of the daily labor. Research may be carried on to elucidate new facts, to confirm previous studies, to record isolated cases of scientific and practical interest, to improve existing methods, or to collect statistics for future study. This special investigation minimizes the dulling effect of routine and acts as a mental stimulus to the laboratory worker. Thus we find the best laboratories continually engaged in research and they who have thus acquired the experimental viewpoint are much more likely to explain an uncommon train of symptoms or determine the nature of a puzzling case.

What is the future of the medical laboratory? Although remarkably well developed at the present time, we find that, in view of the many great problems which medical science must yet solve, these institutions have only begun their work. The discovery of disease germs, yet to be made, new methods in the diagnosis and prevention of infections, and even improvement of existing methods, offer fields for many years of labor. Here and there isolated workers have contributed valuable facts and made important discoveries, but innumerable fundamental problems yet remain. Only recently the advent of new methods have led to morphologic studies of great importance, thus again opening a field which at one time was thought closed. The ex-

tensive subject of functional diseases is being clarified by the methods of chemical analysis now in use and the new science of colloidal chemistry will further aid greatly in the solution of many perplexing medical problems.

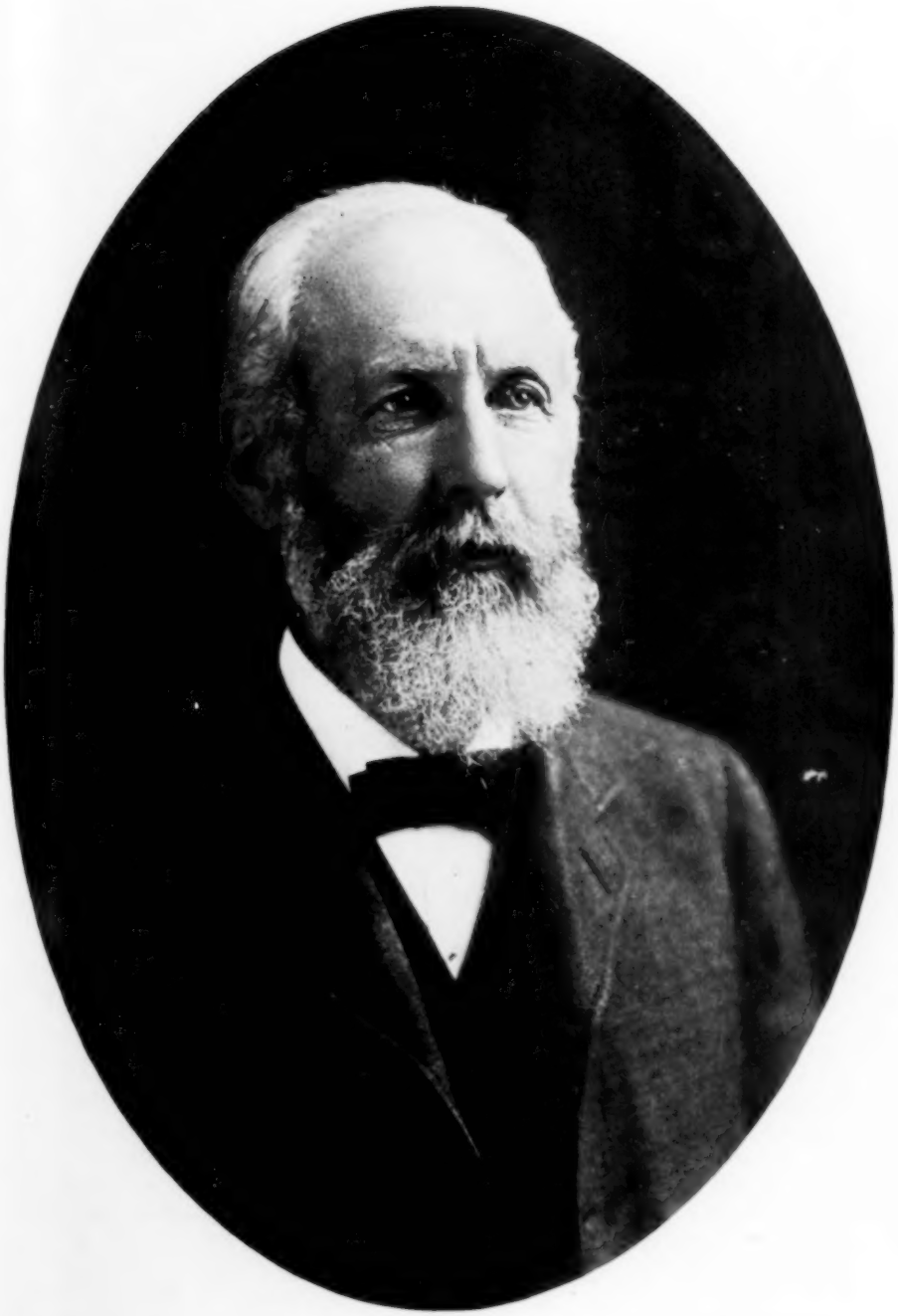
Hand in hand with the discovery of the cause of disease is the problem of therapy. In comparatively few instances can diseases be cured after they have become well established. Chief among these are diphtheria, malaria, hook-worm infection, syphilis and cerebro-spinal meningitis. There are a host of other diseases dependent upon functional derangement of various organs and their alleviation depends largely on hygienic and dietetic measures. Many other abnormalities are relieved usually by the removal of the offending organ and then nature reestablishes the normal state, with or without further assistance. Examples of these are appendicitis, goiter, calculi and tumors. Thus it is seen that the greatest practical progress made in medical science has been along lines of prevention. This has been accomplished primarily by isolation and the elimination of conditions favorable to the growth and transmission of microbes and secondly by preventive inoculation.

Consider for a moment how successfully malaria, yellow fever, plague and smallpox have been controlled. These diseases, in the past, decimated whole populations and at times threatened to destroy entire nations. Who can estimate the value to the world of the control of these four infections alone? The destruction of mosquitoes and rats, the method of vaccination, simple procedures and not at all difficult of application, have already been of immeasurable benefit to mankind. They all represent the work of the medical laboratory, except smallpox vaccination, which was made known to the world by Edward Jenner before the days of medical laboratories. Later day improvements in the production and use of vaccine were made, however, in the laboratory.

The two great objects of medical endeavor in recent years have been to prevent infection, either before or shortly after exposure, and to apply a specific remedy after the onset of symptoms. The success of Pasteur in preventive inoculation against anthrax in sheep led to the adoption of similar methods in many other infectious diseases with varying results. Having apparently exhausted all possibilities along these lines, the laboratory workers turned to chemistry and sought to obtain drugs or chemical products which when injected into the body destroyed the parasites, but without inducing harmful changes in the organs. The most brilliant results obtained have been by

the use of atoxyl in sleeping-sickness and salvarsan in syphilis. Thus it is seen that medical investigation has become an exceedingly complex subject and that the united efforts of the physician, the biologist, the chemist and the physicist are necessary in order to obtain favorable results. Physical science is rapidly looming to the front as an aid in the solution of medical problems and has already accomplished much, as in the application of our knowledge concerning the X-ray and radium in the treatment of disease.

The organization of a well-conducted medical laboratory calls for a competent staff and adequate equipment. The primary object is to render immediate and necessary service in the diagnosis and prevention of disease. This means that a certain amount of routine work will be conducted for the physicians and hospitals in the neighborhood. The second important object of the laboratory is to engage in research. This may be along lines to which the institution is committed, or will depend on the interests of those in charge of the laboratory, or upon accidental findings during the routine examinations. Much valuable work has been accomplished as a result of chance observations, but they really are not accidental, because the workers are ever on the lookout for unusual phenomena. Owing to the liberality of wealthy citizens of this country, many buildings have been erected and equipped for diagnostic and research purposes and they are sufficient for years to come. What is needed urgently is endowment for existing institutions and funds for salaries and materials to conduct research. Many laboratories well equipped as to working space and apparatus are unable to carry on investigations because of lack of finances. It is futile to erect buildings for scientific purposes unless funds are also provided for the work. With such support and encouragement the problem of the infectious diseases and tumors will soon be solved and their eradication is certain to follow. The greater portion of the remaining diseases will be cared for by the science of hygiene which is making such rapid progress.



GROVE KARL GILBERT

THE PROGRESS OF SCIENCE

GROVE KARL GILBERT

FROM the time of Benjamin Franklin and Count Rumford, America has produced distinguished men of science; but it is only in recent years that it has rivalled the older nations in research work. The two sciences first to attain this position were astronomy and geology, in which opportunities for research work were opened through the endowment of observatories and through the state and national support of geological surveys.

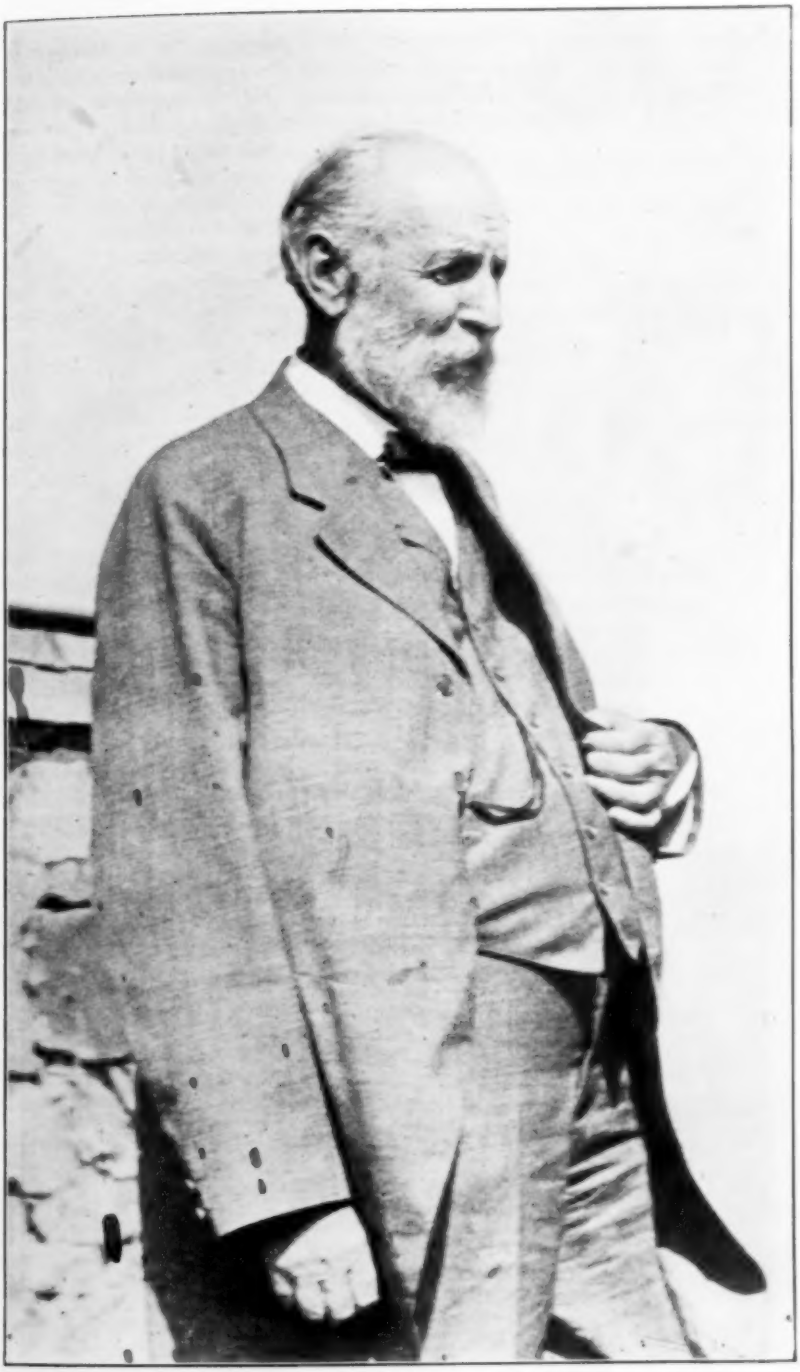
When the United States Geological Survey was organized in 1879, Grove Karl Gilbert had been for eight years engaged in the survey of the western territories under Wheeler and Powell. He was not only a member of the survey from its organization until his death, but shared in the work leading up to its organization, and was in large measure responsible for its admirable methods and results. During this long period Gilbert represented the highest ideals of scientific work, careful observation and sound judgment, philosophical broadness, complete straightforwardness.

Gilbert was born in Rochester in 1843, his father being the portrait painter, Grove Sheldon Gilbert. After graduating from the University of Rochester, he was for some time engaged in Ward's Natural Science Establishment, the training school for a number of distinguished naturalists. In 1869, he began his geological work on the Ohio Geological Survey under Newberry. At that time, when only twenty-eight years of age, he prepared maps showing the ancient glacial waters in the Maumee Valley, the first ever made of ancient lake beaches. His later important work on Lake Bonneville describes the large predecessor of the present Great Salt Lake, which existed in glacial times and overflowed northward to the Columbia River. One of Gilbert's most important early papers was his report on the Henry Mountains published in 1877, describing a new type of mountains, originally areas of sedimentary strata lifted by the injection of lava from beneath, to which the name laccolith is now given. Each of the large number of papers and monographs prepared by Gilbert during his fifty years of scientific activity contains a contribution to the subject.

Professor Herman LeRoy Fairchild, of the University of Rochester, the early home of Gilbert, at a memorial meeting held by the Rochester Academy of Sciences, said:

> Dr. Gilbert's mind was of the reflective, philosophic type. He sought for the explanation and relationship of phenomena. His calm judgment and clear discrimination joined to a spirit of fairness and with gentle manners caused him to be much sought as a critic and helper. He was a sort of father-adviser to the members of the survey. Doubtless much of his thought has found expression in the writings of the younger men who revered and loved him. The writer of this appreciation never heard him say a harsh word of any one.

Gilbert was twice president of the Geological Society of America, no other American geologist having received the honor of a second election. He was president of the American Association for the Advancement of Science and of the American Society of Naturalists. On the approach of the seventy-fifth anniversary of his birth on May 6,



GROVE KARL GILBERT

his friends were asked to send to the Geological Survey letters of congratulation to be handed to him on that day, but he died on May 1.

THE UNIVERSITY OF PARIS

THERE was published last year an appreciation by American scholars of "Science and Learning in France" with a survey of opportunities for American students in French universities. The volume is edited by Professor John H. Wigmore, of Northwestern University, at the time of its preparation president of the American Association of University Professors, and contains articles on French contributions to the several departments of scholarship and science by leading American students with an introduction by Dr. Charles W. Eliot. Appendices give practical details concerning educational advantages for American students in France and the organization and degrees of the institutions of higher learning.

There has now been issued under the auspices of the council of the University of Paris a volume entitled "La Vie Universitaire à Paris" prepared by a number of leading French scholars and to a certain extent addressed to the American student. The publication of such a volume at the present time bears witness to the fine spirit of the French people in maintaining the historic institutions of the country and planning for their future development.

Professor Durkheim, who contributes the chapters on the history and the organization of the university, tells us that Paris is the oldest and largest of the world's universities. It is a position for legitimate pride, even though the margin is not large in either direction. In respect to size, comparisons are difficult, for it depends on which of the educational institutions of a city are included and on how the students are counted. According to *Minerva*, the University of Paris had, before the war, 17,512 students, followed by Berlin with 14,034, Moscow with 9,516 and Petersburg with 8,955. It will now be the United States rather than Russia which will rival Paris in the size of its institutions. Apart from summer school and ex-

THE SORBONNE AS BUILT BY RICHELIEU IN 1642. The Church contains the Tomb of Richelieu. From an engraving by Aveline.

THE CHURCH OF THE SORBONNE AT THE PRESENT TIME. The monument before the Church has been erected in Honor of Auguste Comte.

THE COURT OF HONOR OF THE SORBONNE. Photographed from the Steps of the Church.

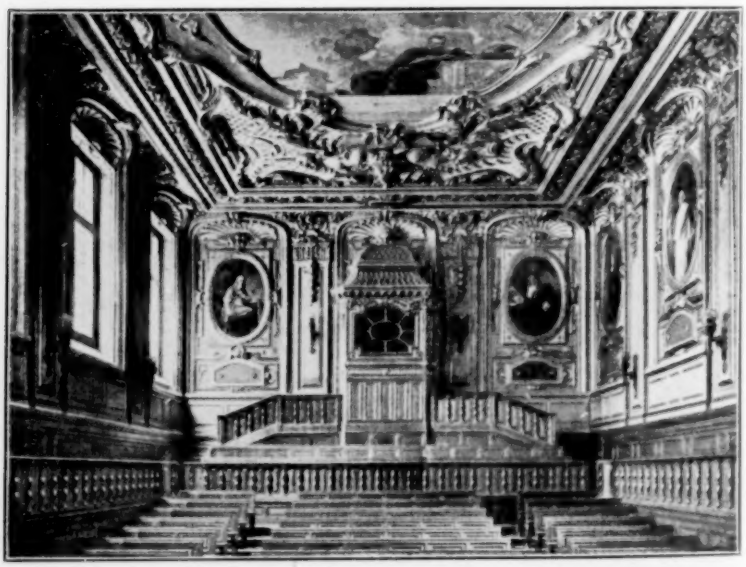
tension courses Columbia had in 1916, 7,327 students, Harvard 5,226, Michigan, 6,276 and California 6,467. But the different institutions for higher learning in Boston or in New York, if their students were combined, would in size rival or surpass Paris and Berlin.

Salerno, a medical school in the ninth century, may claim to have been the earliest of universities, but it was finally closed in 1817. The universities of Paris and Bologna arose in the course of the twelfth century, but Paris claims a slightly earlier organization. Bologna was primarily a law school controlled by the students, Paris a school of theology and philosophy controlled by the masters.

Abelard, teaching first in the cathedral school of Nôtre Dame, attracted crowds of students. He founded other schools and other teachers established schools from which gradually arose the University of Paris. In the thirteenth century and later, colleges or dormitories for poor students were endowed. The Sorbonne was founded in 1303 by Robert de Sorbon for theological students, and was rebuilt by Richelieu in 1627. It survived as a school of theology until the revolution, and in a sense became the university, which for centuries was controlled by the Jesuits, while the forward movement of science and letters proceeded outside, largely under the auspices of the academies.

French education was centralized and made professional and practical by Napoleon, and it was only under the third Republic that Paris once again became a great university and the universities of the provincial cities were recreated.

The Sorbonne has been rebuilt and enlarged threefold, and made the administrative center of the university, whose various buildings are grouped about it. Some pictures are here reproduced from the book which are of interest in relation to the architectural developments of American universities.



EXAMINATION HALL OF THE FACULTY OF LETTERS OF THE UNIVERSITY OF PARIS.

THE COUNCIL ROOM OF THE UNIVERSITY OF PARIS.

THE CHEMICAL WARFARE SERVICE

THE meeting of the American Chemical Society in Cleveland and the National Exposition of Chemical Engineers in New York have brought to general attention the great part played by chemistry in national welfare and in the conduct of the war. Modern warfare is essentially engineering, and there is scarcely any department with which chemistry is not vitally concerned. The part that has been played by our chemists in warfare is well described by Dr. Charles L. Parsons, the secretary of the American Chemical Service, in an address that he gave at Cleveland.

Before the entry of the United States into the war, a census was taken of American chemists, and full information was obtained concerning the qualification of some 15,000. In the early part of February, 1917, the president of the American Chemical Society, Dr. Julius Stieglitz, offered the services of the members to President Wilson in any emergency that might arise and received an appreciative reply.

Active work was begun by the Bureau of Mines and other agencies which culminated in the organization of the Chemical Warfare Service in June, 1918. As Dr. Parsons says it was a real epoch in the history of chemistry in warfare when, as a result of conferences held at the Bureau of Mines with officers from the Medical Corps, War College, General Staff, Navy and civilian chemists, the Chemical Service Section was established as a unit of the National Army.

All newly drafted chemists are assigned to the Chemical Warfare Service to be detailed or transferred or furloughed where needed. It is charged with the "responsibility of providing chemists for all branches of the government and assisting in the procuring of chemists for industries essential to the success of the war and government." It has an authorized personnel of 45,000, of

which any portion may be chemists if needed. At present there are approximately 1,400 graduate chemists in the Chemical Warfare Service.

Dr. Parsons concluded his address with the words:

War, the destroyer, has been on the other hand the incentive to marvelous chemical development with a speed of accomplishment incomprehensible in normal times. Discoveries made in the search for instruments of destruction are already in use for the development of chemical industry. Many others, unpublished as yet, and to remain unpublished until the war is over, will prove of the utmost benefit to mankind. The same agencies that add to the horror of war to-day, the same reactions which are used in the development of explosives and poisonous gases on the one hand, and in counteracting their effect on the other, will find immediate and useful application in the years to come. The war has been prolonged by chemistry. The German chemist, apparently working for years with war in view, has supplied the German armies with the means for their ruthless warfare, but the chemists of America and our Allies have met them fully in chemical development, and when the chemical story of the war is written where all can read, it will be the verdict of history that the chemists of America were not found wanting. The chemical program of the United States Army and Navy has been at all times ahead of our trained man power and the mechanical devices necessary to apply what the chemists of America have produced.

SCIENTIFIC ITEMS

WE record with regret the death of Aaron Nicholas Skinner, formerly professor of mathematics at the U. S. Naval Academy and assistant astronomer of the Naval Observatory; of Charles R. Eastman, of the American Museum of Natural History, the author of important contributions to paleichthyology; of Bertram Hopkins, professor of mechanism and applied mechanics in Cambridge University, Colonel in the British Army, and of O. Henrici, F.R.S., emeritus professor of mechanics and mathematics in the Central Technical College of the City and Guilds of London Institute.

MAJOR GENERAL MERRITTE W. IRELAND, of the Medical Corps, has been appointed Surgeon General of the Army, to succeed Major William C. Gorgas, who was retired on October 5. General Gorgas will remain in Europe as the medical representative of the United States Army at the Interallied War Council.—Dr. Arthur L. Day, director of the Geophysical Laboratory of the Carnegie Institution of Washington since its establishment in 1906, home secretary of the National Academy of Sciences, has resigned to accept a research position with the Corning Glass Works, Corning, N. Y.

THE statutory meeting of the general committee of the British Association for the Advancement of Science was held in London in July, and at this meeting much disappointment was expressed that for the second year in succession it has been found impossible to arrange for an ordinary meeting. A resolution was passed unanimously asking the council to arrange for a meeting in London next year, if it should prove impossible to arrange to meet at Bournemouth. The question as to the type of meeting which it was desirable to hold was left to the council to decide.

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Teaching Business Correspondence: Edward H. Gardner.
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